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TABLE OF CONTENTS

Page

Introduction..... iv

Crops and Soils Research Reports

Copper and Zinc in Coastal Plain Soils: I. Effect of added phosphorus on copper toxicity to oats. II. Toxic limits of copper and zinc to soybeans.
R. F. Korcak and J. H. Axley..... 1

Breeding for Disease Resistance in Maryland Tobacco, 1973.
M. K. Aycock, Jr..... 7

Heterosis and Combining Ability Estimates for Certain Agronomic and Chemical Traits of Maryland Tobacco.
R. Hsieh, M. K. Aycock, Jr., and C. L. Mulchi..... 12

Performance of Breeding Lines in the Preliminary Variety Test, 1973.
M. K. Aycock, Jr..... 18

Performance of Maryland Tobacco Varieties and Breeding Lines, 1972.
M. K. Aycock, Jr..... 21

Tobacco Variety - Nitrogen Rate Study.
M. K. Aycock, Jr. and C. G. McKee..... 24

The Fertilizer Value of Broiler Litter for Topdressing Small Grains.
V. A. Bandel, C. E. Rivard, and F. R. Mulford..... 27

Nitrogen Fertilization of Small Grains.
V. A. Bandel..... 35

No-Tillage Corn Fertilization.
V. A. Bandel..... 40

Sulfur Fertilization.
V. A. Bandel..... 49

Zinc Fertilization of Corn and Soybeans.
V. A. Bandel and C. E. Rivard..... 55

Control of Established Johnsongrass in Corn with Thiocarbamate Herbicides.
G. W. Burt..... 60

Control of Established Johnsongrass in Soybeans with Toluidine Herbicides After Two Consecutive Years.
G. W. Burt..... 64

Control of Johnsongrass in Corn with Thiocarbamate Herbicides After Two Consecutive Years.
G. W. Burt..... 67

Page

Control of Johnsongrass in Soybeans After Two Years of Treatment with Trifluralin, Glyphosate and Alachlor.
G. W. Burt..... 70

A Comparison of Sunflower Varieties under Different Managements for Silage.
N. A. Clark..... 74

Comparison of Propionic Acid and Ammonium Isobutyrate as Preservatives for High Moisture Hay.
C. C. Sheaffer and N. A. Clark..... 81

Effects of Sewage Sludge on Soil plus the Yield and Chemical Composition of Corn and Soybeans.
A. M. Decker, J. M. Walker, and R. L. Chaney..... 88

Soil Temperature Responses of Corn Hybrids Developed for Either Warm or Cool Climates.
A. M. Decker and J. M. Walker..... 95

Ground Water Table Studies on the Bertie and Mattapex Soils.
J. E. Foss and F. P. Miller..... 100

Breeding and Evaluation of Kentucky Bluegrass for Turf.
J. R. Hall..... 105

Effect of Postemergence Nonselective Herbicides and Fertilization upon Poa annua Populations in Kentucky Bluegrass (Poa pratensis L.) Sod.
J. R. Hall..... 110

Effect of Repeated Preemergence Herbicides upon Smooth Crabgrass Control, Turfgrass Quality and Root Activity.
J. R. Hall, E. E. Deal, and A. J. Powell..... 116

Performance of Slow Release Fertilizers on Bentgrass Greens.
J. R. Hall..... 121

Quackgrass Eradication Chemicals.
J. R. Hall and J. V. Parochetti..... 129

The Use of Chelated Iron and Nitrogen to Improve Sod Quality.
J. R. Hall..... 134

Tee Turf Research.
D. T. Hawes..... 140

Effect of Sucker Control Agents, Method of Application and Time of Harvest on Maryland Tobacco.
J. H. Hoyert..... 142

The Feasibility of Transplanting Tobacco Seedlings in Pressed Peat-Soil Cubes.
J. H. Hoyert..... 147

Page

Regional Tests with Tobacco Sucker Control Agents on Maryland Tobacco.
J. H. Hoyert and G. L. Steffens..... 151

The Use of 2-Chloroethylphosphonic Acid (CEPA) to Improve Maturity of Maryland Tobacco.
J. H. Hoyert..... 154

Field Testing for Lodging Resistance of Maryland Tobacco Varieties with Artificially Produced Wind.
C. G. McKee and M. K. Aycock, Jr..... 158

Irrigation with Maryland Tobacco.
C. G. McKee..... 161

Response of Corn to Various Tillage Practices.
F. P. Miller..... 164

Correlations of Air Pollution Damage on Maryland Tobacco Cultivars and Hybrids with Certain Agronomic, Chemical and Physical Properties of Cured Tobacco.
R. Hsieh, C. L. Mulchi, and M. K. Aycock, Jr..... 170

Correlation of Air Pollution Susceptibility of Maryland Tobacco Cultivars and Hybrids with Physical Characteristics of the Plant.
R. Hsieh, C. L. Mulchi, and M. K. Aycock, Jr..... 177

Correlation of Air Pollution Damage with Certain Chemical Components in Freeze-Dried Green-Leaf Tissue from Maryland Tobacco Cultivars and Hybrids.
R. Hsieh, C. L. Mulchi, and M. K. Aycock, Jr..... 183

Survey of Total Nitrogen, Total Alkaloids and Total Chloride Contents in Maryland Tobacco from 1971, 1972 and 1973 Crops.
C. L. Mulchi and C. G. McKee..... 189

Long Season N.E. Diallel Single Cross Corn Variety Test.
J. L. Newcomer..... 196

Herbicides for Conventionally Planted Corn.
J. V. Parochetti..... 197

Herbicides for No-Tillage Corn and Soybeans.
J. V. Parochetti..... 206

A Protectant for Corn Injury Caused by EPTC, Butylate and Vernolate.
J. V. Parochetti..... 211

Residual Effect of Thirteen Cropping Systems on Corn Yield and Soil Aggregation.
E. Strickling..... 214

Effectiveness of Forest and Grass Buffer Strips in Reducing Stream Pollution by Animal Wastes.
R. C. Doyle, G. V. Schultz, and D. C. Wolf..... 216

INTRODUCTION

Research Program in the Department of Agronomy

This report gives the research in progress in the Department of Agronomy. The research program in the Department includes the development of improved crop varieties and improved soil and crop management practices that result in more efficient production. Considerable emphasis is also given to research on soil and water conservation, soil and water use, soil-water pollution, air pollution and the disposal of waste materials.

The wide range of soils and 1.9 million acres of agronomic crops (corn, soybeans, tobacco, small grain, turfgrasses, hay, and pasture) grown in the state with a value of approximately 249 million dollars emphasize the size and importance of the research program in agronomy. To solve crops and soils problems research work is conducted at University Laboratories, on the outlying Experiment Station Farms, and cooperatively with farmers, golf course superintendents, and others throughout the state. The help and cooperation received from the many people in the state in carrying out our research program is greatly appreciated.

James L. Miller

Chairman, Department of Agronomy

R. J. Haw

Acting Director, Maryland Agric. Expt. Sta.

Copper and Zinc in Coastal Plain Soils:
I. Effect of added phosphorus on copper toxicity to oats
II. Toxic limits of copper and zinc to soybeans.

R. F. Korcak and J. H. Axley
Department of Agronomy

Purpose and Objectives

Copper and zinc toxicites in soils of the Coastal Plain of Maryland have received little attention in the past. This fact, plus the continuing use of Coastal Plain soils for heavy applications of chicken manure and the increasing consideration of these soils as possible sites for disposal of sewage sludge containing these heavy metals, necessitated this investigation. The objectives of this research were:

1. To determine the limits of copper additions to a Mattapex silt loam for the growth of oats when large phosphate fertilizer treatments are used.

2. To determine the toxic limits for soybeans of copper and zinc in a Sassafras sandy loam and a Mattapex silt loam soil.

Effect of Added Phosphorus on Copper Toxicity to Oats

Procedure

A Mattapex silt loam inherently low in phosphorus was treated with copper and phosphorus fertilizers. Copper applications ranged from 0 to 600 lbs/A and phosphorus from 0 to 1556 lbs/A as P_2O_5. Norline oats were grown on these soils in the greenhouse for 60 days.

Results

The yields of oats are presented in Figure 1. In this soil which was low in phosphorus, yields increased with each addition of phosphorus and decreased with each addition of copper beyond the 150 lbs/A treatment.

With an application of 450 lbs/A of copper the yield of oats was greatly reduced (Figure 1). Generally, the higher the amount of added phosphorus the lower the plant copper level (Figure 2) and the greater the yield.

Summary

Applications of phosphorus to a low phosphorus Mattapex silt loam decreased the percent of copper in the plant and increased oat yields. However, when more than 150 lbs/A of copper was added to this soil the yield of oats was reduced.

Toxic Limits of Copper and Zinc to Soybeans

Procedure

Two separate 30-day greenhouse experiments were conducted to determine the effect of additions of various amounts of copper plus zinc to a limed and unlimed Sassafras sandy loam and a Mattapex silt loam soil on the growth of soybeans. Both copper and zinc were applied together to the soil in equal portions ranging from 0 to 600 lbs/A for both zinc and copper.

Results

The addition of copper plus zinc on the Sassafras soil resulted in decreased yields when compared to yields from copper alone or zinc alone on both the limed and unlimed soils (Table 1). The Mattapex soil used in this experiment had a copper deficiency so the initial additions of copper to this soil increased yields whereas further additions dropped yields. On the Mattapex soil the yield reductions resulting from zinc plus copper soil treatments were only noted after a copper deficiency had been corrected. It can also be noted in Table 1 that zinc alone produced a greater toxic effect than copper. This factor is especially important

because manures and sewage sludges often contain more zinc than copper. In poultry manure and some sewage sludges there is 10 times more zinc than copper. Table 1 shows that lime additions to Maryland soils will reduce but not prevent the toxicity of copper and zinc to these soils.

Summary

1. Copper additions to toxic or near toxic zinc treatments on a Sassafras soil depressed soybean yields when compared to zinc or copper alone. This effect was also observed with the Mattapex soil after an apparent copper deficiency had been corrected.

2. Liming decreased the toxicity of both copper and zinc to soybeans grown on Sassafras and Mattapex soils but even lime could not prevent toxicities of copper or zinc when quantities of copper or zinc approached 600 lbs/A on the Mattapex silt loam soil and 200 lbs/A on the Sassafras sandy loam soil.

Table 1. Percent decrease or increase in soybean yields obtained on the unlimed and limed Sassafras and Mattapex soil treated with Cu alone, Zn alone and Cu plus Zn.

Treatment	Experiment		
	Cu alone	Zn alone	Cu plus Zn
lbs/acre	----------	%----------	
----------unlimed Sassafras----------			
200**	1* decrease	80 decrease	96 decrease
400	79* decrease	90 decrease	100 decrease
600	84* decrease	95* decrease	100 decrease
----------limed Sassafras----------			
200	5* decrease	26* decrease	35 decrease
400	23* decrease	52 decrease	63 decrease
600	37* decrease	64* decrease	77 decrease
----------unlimed Mattapex----------			
200	56* increase	6 decrease	70 increase
400	14* increase	15 decrease	42 decrease
600	15* decrease	47* decrease	79 decrease
----------limed Mattapex----------			
200	11* increase	2* decrease	6 increase
400	15* increase	5 decrease	29 increase
600	22* decrease	38* decrease	32 decrease

* Values obtained by interpolation. For Cu alone the 200 value was interpolated from 150 and 225 lbs/A treatments; 400 from 375 and 450; and 600 from 450 and 525. For the Zn alone the 600 value was interpolated from 400 and 800 lbs/A treatments and 200 from 0 and 400.

**The 200 lbs/A treatment of Cu + Zn = 200 lbs/A Cu plus 200 lbs/A Zn, etc.

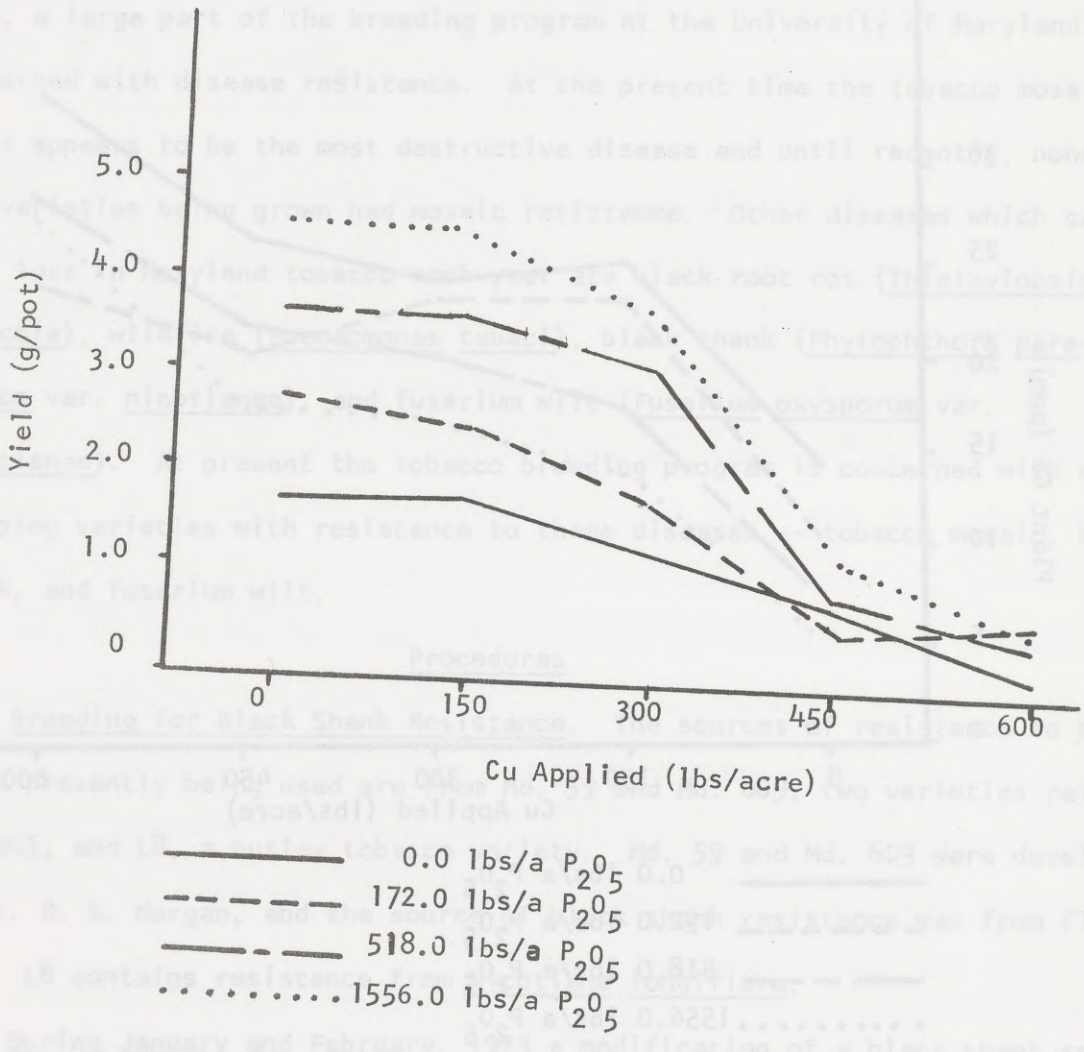

Fig. 1. The effect of applied Cu and P on the yield of oats grown for 60 days on a Mattapex silt soil in the greenhouse.

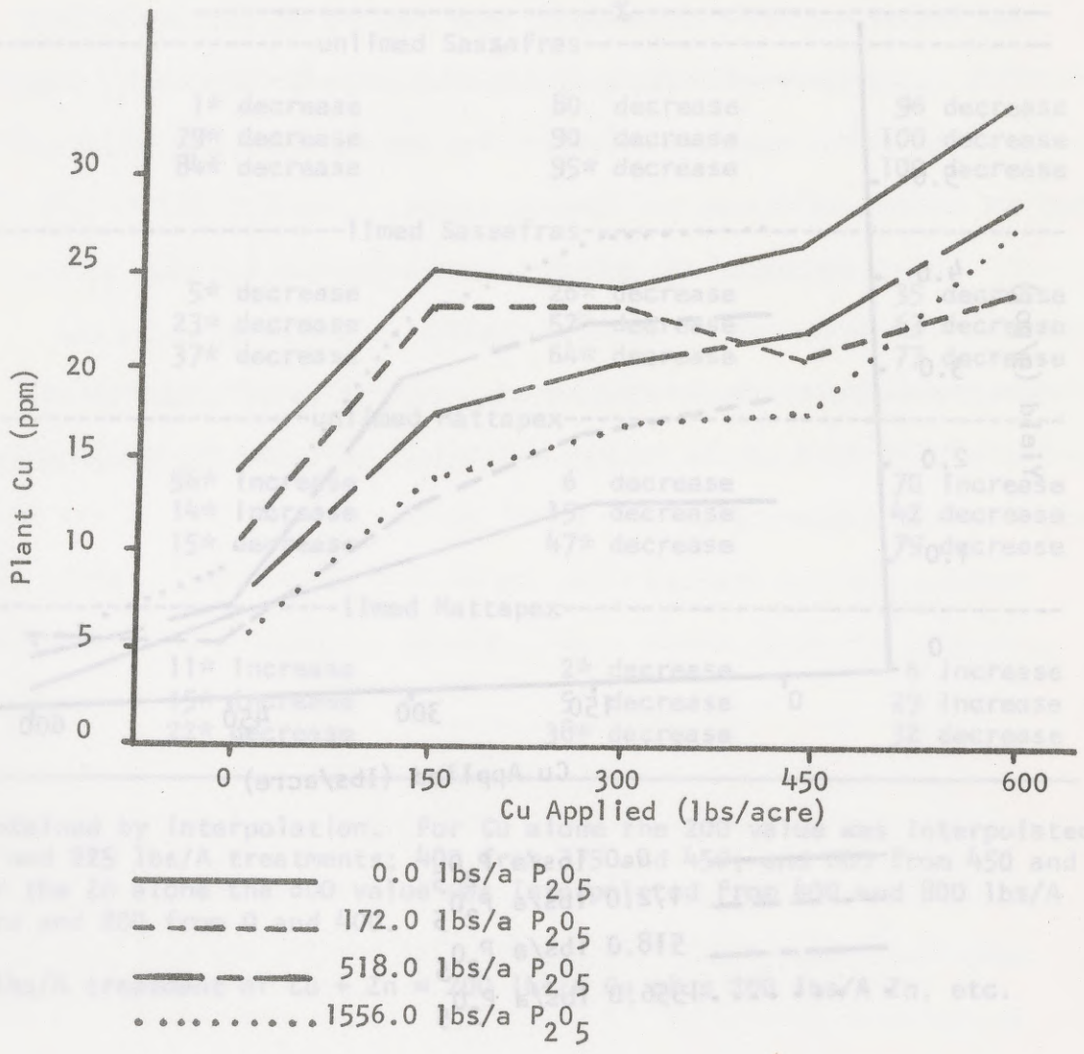

Fig. 2. The effect of applied copper and phosphorus on the copper content of oats grown for 60 days on a Mattapex silt loam in the greenhouse.

Breeding for Disease Resistance in Maryland Tobacco, 1973

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

A number of diseases attack tobacco grown in southern Maryland; therefore, a large part of the breeding program at the University of Maryland is concerned with disease resistance. At the present time the tobacco mosaic virus appears to be the most destructive disease and until recently, none of the varieties being grown had mosaic resistance. Other diseases which cause some loss in Maryland tobacco each year are black root rot (Thielaviopsis basicola), wildfire (Pseudomonas tabaci), black shank (Phytophthora parasitica var. nicotianae), and fusarium wilt (Fusarium oxysporum var. nicotianae). At present the tobacco breeding program is concerned with developing varieties with resistance to three diseases -- tobacco mosaic, black shank, and fusarium wilt.

Procedures

Breeding for Black Shank Resistance. The sources of resistance to black shank presently being used are from Md. 59 and Md. 609, two varieties released in 1965; and L8, a burley tobacco variety. Md. 59 and Md. 609 were developed by Dr. O. D. Morgan, and the source of black shank resistance was from Florida 301. L8 contains resistance from Nicotiana longiflora.

During January and February, 1973 a modification of a black shank screening procedure utilized at the University of Kentucky was used to screen 100 entries in the F_2 to F_{10} generations. Sixty entries were segregating breeding material and 40 entries were individual plant selections of Md. 872. The procedure involved planting approximately 10 to 15 seeds of an entry in a vermiculite-filled 50 ml polypropylene centrifuge tube. About 4 weeks after

seeding the seedlings were inoculated with the black shank fungus. Two weeks after inoculation the entries were scored on above ground plant parts (leaves and stems) and the roots. A scoring system of 0, 1, 2, 3 and 4 was utilized for the leaves and stems with a score of 0 representing no symptoms of the disease and a score of 4 representing complete death of all seedlings. A similar system was used for rating the roots. A rating of 0 represented no symptoms (roots white) and 4 represented severe browning of the entire root system.

Breeding for Mosaic Resistance. During the summer of 1972, 45 breeding lines in the F_2 to the F_8 generations were screened for mosaic resistance in the breeding nursery in the field. Each entry was represented by 28 plants. Just prior to flowering, plants were inoculated with the tobacco mosaic virus by rubbing the leaf with cheesecloth saturated in a solution of the virus. Approximately one week after inoculation, ratings were made on the number of resistant and susceptible plants in each entry. At the time of scoring the resistant plants exhibited small necrotic spots at the site of inoculation while the susceptible plants exhibited the characteristic mosaic pattern of dark and light green areas in the new growth. The necrotic spots of the resistant plants are due to a hypersensitive reaction of the leaf tissue to the virus. When the virus contacts the leaf cells, the cells die at such a rapid rate that the virus cannot spread.

Results

Black Shank Resistance. The results of the screening procedure for black shank resistance are presented in Table 1. Considerable variation was found among the entries for black shank resistance. A few entries appeared to have complete resistance while others were completely susceptible. From the leaf and stem scores, 69.0% of the entries received a score of 1.5

or better while 8.0% of the root scores fell within this same range. Entries with a leaf and stem score of 1.5 would probably have adequate resistance under field conditions in southern Maryland. The high root scores observed for Md. 872 suggest that this new variety contains a very low level of resistance and would not be adequate under most Maryland conditions. Therefore, farmers with a history of black shank on their farm should use either Md. 59 or Md. 609 in their production program.

One reason for the wide variation among the entries for black shank resistance could be due to the nature of inheritance of the resistance. Resistance from the Florida 301 source is believed to be dependent upon two major genes and several modifiers; therefore, through breeding the ultimate objective is to capture the two major genes and accumulate as many of the modifiers as possible. Resistance from L8 is simply inherited and produces plants with a very high level of resistance.

Mosaic Resistance. The results of the tobacco mosaic screening procedure are shown in Table 2. Resistance is determined by a single dominant gene; therefore, the plants fell into one of two classes -- resistant or susceptible. Screening results showed that all entries were resistant. For the entries, 24.0% appeared to be homozygous or true breeding and 76.0% were heterozygous or still segregating at the mosaic resistant locus.

Summary

Breeding lines with resistance to black shank and tobacco mosaic are being developed. Screening techniques which are relatively simple and reliable are being used in the greenhouse and summer breeding nursery. Lines with good resistance based on greenhouse and field results were advanced an additional generation in the field nursery during the summer. Selection for plant type and other desirable agronomic traits was done in the field nursery.

Some of the breeding lines which have good resistance and desirable plant types have been observed for agronomic acceptance in preliminary field trials under replicated conditions.

Table 1. Percentage distribution of entries screened for black shank resistance in the greenhouse, 1973. (n = 100).

Score class [a]	Breeding material		Md. 872	
	Leaves and stems	Roots	Leaves and stems	Roots
0.0	12	2	0	0
0.5	10	3	0	0
1.0	22	3	5	0
1.5	25	0	20	0
2.0	10	15	22	0
2.5	12	30	40	2
3.0	8	25	10	10
3.5	0	22	2	45
4.0	2	0	0	43

[a] 0 = completely resistant; 4 = dead.

Table 2. Percentage of resistant (AA), segregating (Aa), and susceptible (aa) genotypes screened for tobacco mosaic resistance, field nursery, 1972. (N = 45).

Genotype	Breeding material, %
AA	24
Aa	76
aa	0

Heterosis and Combining Ability Estimates for Certain Agronomic and Chemical Traits of Maryland Tobacco

Rosanna Hsieh, M. K. Aycock, Jr., and C. L. Mulchi
Department of Agronomy

Purpose and Objectives

Progress through selection of superior genotypes in Maryland tobacco depends primarily on the amount and type of genetic variation present in the breeding population. The type of genetic variation found in a population is related also to the amount of heterosis found for the various agronomic and chemical traits under consideration. Therefore, information concerning heterosis and combining ability estimates are needed in order to assist in planning future breeding programs. The results of our investigation for these two areas are presented in this report.

Procedures

In 1972 eight Maryland tobacco cultivars (parents) and 28 F_1 hybrids (all possible crosses among the eight parents excluding reciporcals) were grown at three locations. The 36 entries (parents and hybrids) were grown in a randomized complete block design with three replications.

Agronomic data were collected according to the procedures previously outlined by Aycock *et al.* (1973, Md. Agr. Exp. Sta. MP 839). Total alkaloids and total nitrogen determinations were made on a composite sample of cured leaves from the whole plant. Weather fleck ratings were made on 15 leaves from the bottom to the top of the plant. Each leaf received a score of 1 to 5 with 1 showing no fleck symptoms and 5 indicating a severely flecked leaf. The individual leaf scores for each plant were totaled so a score of 15 would indicate no fleck and a score of 75 would indicate severe flecking.

Just prior to harvest, green tissue samples were collected from lower, middle, and upper stalk positions, and freeze-dried for each plot. From the freeze-dried green tissue samples data on total nitrogen, total alkaloids, total carbohydrates, and total polyphenols were obtained. Weather fleck scores for the lower five leaves, middle five leaves, and top five leaves were calculated to correspond with the three stalk positions for freeze-dried green tissue samples. A weather fleck score of five at any stalk position would indicate no fleck symptoms and a score of 15 would indicate severe flecking.

An estimate of heterosis was determined and expressed as percent difference of the F_1 hybrids from the midparent average. Combining ability estimates were determined from the hybrid data using the procedure outlined by Matzinger and Kempthorne (1956, Genetics 41: 822-833).

Results

Estimates of heterosis and parent and hybrids means for the various agronomic traits, weather fleck ratings (whole plant), and total alkaloids and total nitrogen determinations on the cured leaf are presented in Table 1. A significant heterosis response was observed for three traits. The hybrids had a higher yield and value per acre, and were lower in total nitrogen than the parent cultivars.

General combining ability (g.c.a.) mean squares were significant for eight of the 12 traits studied (Table 2). Specific combining ability (s.c.a.) was significant for yield per acre and total nitrogen. The g.c.a. x L and s.c.a. x L interactions were significant for several traits indicating that unbiased genotypic component estimates could best be obtained when the genetic material is grown in several environments.

Heterotic responses for weather fleck and the four chemical traits measured on the freeze-dried green tissue samples are shown in Table 3. The hybrids were significantly lower than the parent cultivars for total alkaloids and total nitrogen.

Mean squares for g.c.a. were significant for weather fleck and total polyphenols, and s.c.a. was significant for weather fleck, total alkaloids, total carbohydrates, and total polyphenols (Table 4).

The small heterotic responses found for most agronomic and chemical traits, coupled with primarily significant general combining ability estimates, would suggest that additive genetic variance was more important than nonadditive genetic variance for most traits. Some exceptions were observed which would suggest nonadditive genetic variance to be important. Specific combining ability estimates for yield and total nitrogen (composite cured leaf sample) were significant. Also a significant heterotic response was noted for these two traits. Additional testing would be necessary before the nonadditive genetic variance estimates in this study could be determined to be due to dominance and/or epistatic efforts.

Therefore, these results suggest that through selection, improved cultivars of Maryland tobacco could be developed with high yields, good quality, acceptable chemical content, and a good level of weather fleck tolerance.

Summary

A diallel set of crosses involving eight parent cultivars and 28 F_1 hybrids were grown in a randomized complete block design with three replications at three locations in 1972.

Significant heterosis was observed for yield and value per acre, and total nitrogen (composite cured leaf cample). For the freeze-dried green tissue samples, heterosis was significant for total alkaloids and total carbohydrates.

The predominance of additive genetic variance in the population, as suggested by the significant estimates of general combining ability, indicated that considerable progress could be made in developing improved tobacco cultivars through selection.

Table 1. Combined means and heterosis for parents and hybrids averaged over three locations for 12 agronomic and chemical traits in Maryland tobacco, 1972.

Trait	Means		Heterosis
	Parents	Hybrids	%
Yield per acre, lbs	1362	1412	3.7 *
Value, $/A	1039	1092	5.1 *
Price, $/cwt	76.60	77.00	0.5
Plant height, cm	73.70	75.30	2.2
Leaves per plant	18.80	18.90	0.5
Internode length, cm	3.91	3.98	1.8
Days to flower	62.60	61.90	-1.1
Total alkaloids, %	1.77	1.76	-0.6
Total nitrogen, %	2.49	2.41	-3.2 *
Duration of burn, sec.	17.04	17.40	2.1
Filling capacity, cc/g	7.90	7.86	-0.5
Weather fleck, 15-75	27.10	28.10	3.7

* Significant at the 5% level.

Table 2. Combined analysis of variance mean squares for general (g.c.a.) and specific (s.c.a.) combining ability, g.c.a. x locations (L), and s.c.a. x L for 28 F_1 Maryland tobacco hybrids grown at three locations, 1972.

Trait	Mean squares			
	g.c.a.	s.c.a.	g.c.a. x L	s.c.a. x L
Yield per acre	326,237	55,258 **	100,469 **	10,945
Value	234,013 **	27,492	29,611	22,522
Price	23.83 **	4.20	2.14	3.70 *
Plant height	299.33 **	40.20	47.96	40.37
Leaves per plant	12.30 *	1.13	3.37	1.86
Internode length	1.10 **	0.16	0.04	0.11 **
Days to flower	89.50 **	9.57	21.81	25.91 **
Total alkaloids	0.645	0.162	0.339 **	0.110
Total nitrogen	0.352	0.119 *	0.148 *	0.064
Duration of burn	40.66	8.72	33.81 **	10.30
Filling capacity	0.416 **	0.096	0.002	0.216 **
Weather fleck	242.5 **	19.0	36.1 *	15.7 *

* Significant at the 5% level.
** Significant at the 1% level.

Table 3. Means and heterosis for parents and hybrids for weather fleck and four chemical constituents determined from freeze-dried green tissue over different stalk positions at Upper Marlboro, Md., 1972.

Trait [a/]	Mean		Heterosis
	Parents	Hybrids	%
Weather fleck, 5-25	9.84	9.86	0.2
Total nitrogen, %	4.12	4.20	1.9
Total alkaloids, %	1.48	1.40	-5.4 **
Total carbohydrates, %	4.74	4.48	-5.5 *
Total polyphenols, %	2.70	2.55	-5.6

[a/] Weather fleck, total nitrogen, and total alkaloids are averaged over three stalk positions, and total carbohydrates and total polyphenols are averaged over two positions.

* Significant at the 5% level.

** Significant at the 1% level.

Table 4. Combined analysis of variance mean squares for general (g.c.a.) and specific (s.c.a.) combining ability, g.c.a. x stalk positions (SP), and s.c.a. x SP for 28 F_1 Maryland tobacco hybrids grown at Upper Marlboro, Md., 1972.

Trait	Mean squares			
	g.c.a.	s.c.a.	g.c.a. x SP	s.c.a. x SP
Weather fleck	68.84 **	7.37 **	12.33 **	1.36
Total nitrogen	0.202	0.141	0.120	0.094
Total alkaloids	0.206	0.098**	0.107*	0.055
Total carbohydrates	11.08	8.53 *	4.30	3.66
Total polyphenols	300.43 *	82.89 *	25.69	13.19

* Significant at the 5% level.

** Significant at the 1% level.

Performance of Breeding Lines in the Preliminary Variety Test, 1973

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

The initial phase of a breeding program is developmental. Following a desired cross or series of crosses, selection for superior lines is conducted for a number of segregating generations. As new lines reach homozygosity information concerning agronomic and chemical performance is needed. The preliminary variety test is the initial screening process for new breeding lines. Superior breeding lines in this test are then included in the Official Variety Test for further evaluation.

Procedures

In 1972 a group of near homozygous lines with resistance to black shank and/or tobacco mosaic were selected from the tobacco breeding nursery for yield and quality evaluations. These breeding lines were tested in 1973 at Upper Marlboro.

Thirty-two breeding lines, three standard varieties (Md. 609, Md. 64 and Md. 872), and one cigar variety were included in the test. The experimental design was a randomized complete block with three replications.

Results

The performance of the 32 breeding lines and the standard varieties is shown in Table 1. Entries 20 and 28 were similar to Md. 64 and Md. 872 in yield and dollar return per acre. Entry 24 was superior to Md. 609 and Md. 872 for dollars per hundredweight. Considerable variation was observed also among the various breeding lines for days to flower and chemical con-

stituents. After an additional seed increase in the breeding nursery, the top breeding lines from this test will be advanced to the Official Variety Test, and also used as breeding material in future crosses.

Summary

The performance of several breeding lines was very good when compared with the standard varieties. These breeding lines will be advanced to the Official Variety Test, and also used as breeding material in future crosses.

Table 1. Performance of advanced breeding lines of Maryland tobacco in a preliminary variety trial at Upper Marlboro, Md., 1973.

Entry	Yield per acre (lb.)	Value $/A	Value $/cwt.	Days to flower	Total alkaloids (%)	Total nitrogen (%)
1	2127	1704	80.15	53.7	2.34	2.40
2	2032	1668	82.11	50.7	2.20	2.17
3	1897	1578	83.20	50.3	2.51	2.54
4	1920	1594	83.00	55.0	2.79	2.66
5	2000	1682	84.13	52.0	2.75	2.73
6	2149	1801	83.75	53.7	2.86	2.71
7	2061	1730	83.89	54.3	2.28	2.72
8	2222	1854	83.46	53.7	2.20	2.54
9	2144	1786	83.31	53.3	2.36	2.64
10	2068	1729	83.65	52.3	2.06	2.39
11	1906	1580	82.88	50.3	2.15	2.41
12	2073	1732	83.46	52.3	2.42	2.79
13	2075	1715	82.69	51.7	2.43	2.54
14	2028	1676	82.67	51.7	2.86	2.62
15	2032	1647	81.06	55.3	2.00	2.62
16	1897	1560	82.15	52.3	2.51	2.64
17	2102	1756	83.45	51.7	2.33	2.16
18	2056	1738	84.52	51.0	2.10	2.22
19	2083	1728	82.99	48.3	1.98	2.36
20	2414	1976	81.87	54.7	2.05	2.65
21	1884	1528	81.07	49.7	2.52	2.49
22	1917	1618	84.41	49.7	2.60	2.58
23	2059	1721	83.58	53.7	2.61	2.57
24	2216	1886	85.09	52.7	2.18	2.44
25	2051	1706	83.19	52.7	2.38	2.26
26	2126	1755	82.54	56.0	2.69	2.84
27	2168	1825	84.16	55.0	2.20	2.64
28	2306	1919	83.19	57.0	2.19	2.92
29	2018	1694	83.93	50.7	1.83	2.27
30	2004	1658	82.70	53.3	2.30	2.35
31	2111	1743	82.59	52.0	1.80	2.22
32	2079	1738	83.53	56.7	1.89	2.46
Md. 872	2308	1914	82.89	53.3	1.90	2.60
Md. 872	2308	1912	82.83	53.3	1.87	2.50
Pennbel 69	2161	1734	80.22	55.0	2.62	2.45
Md. 609	1941	1618	83.30	54.3	2.45	2.91
Md. 64	2337	1907	81.62	52.0	1.80	2.18
Mean	2089	1733	82.95	52.8	2.29	2.52
L.S.D. (5%)	210	183	1.38	3.2	0.49	0.41
(1%)	280	244	1.84	4.3	0.65	0.54
C.V. (%)	6.2	6.5	1.0	3.8	13.1	9.9

Performance of Maryland Tobacco Varieties and Breeding Lines, 1972

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

The Official Variety Test is the final phase of the breeding program and has three main objectives: (1) To obtain additional information on the varieties presently being grown by the majority of the tobacco farmers, (2) to evaluate advanced breeding lines which appear to have potential as a new variety, and (3) to provide a guide to Maryland tobacco farmers for use in choosing a variety to produce their best crop.

Procedures

Each year the variety tests are conducted at three locations with varying soil types. The tests are located on a Monmouth fine sandy loam at Upper Marlboro, Galestown loamy sand at Davidsonville, and Beltsville silt loam at Dentsville.

The 1972 test which is included in the present report contained four varieties and twelve breeding lines. Eight breeding lines in the test were developed by the USDA at Beltsville under the direction of H. A. Skoog. Four breeding lines were Agricultural Experiment Station entries with M872 from the Agronomy Department and B164, B184, and B259 from the Botany Department.

Four replications of a randomized complete block design were used at each location. Each plot consisted of one row of 23 competitive plants. The plots were three feet apart and plants spaced two feet apart in the plot. Fifteen competitive plants per plot were cut at harvest.

The various agronomic and chemical characteristics measured and methods of data collection have been outlined by Aycock *et al.*, 1972, Md. Agr. Exp. Sta. Mis. Pub. 798.

Results

The average performance of the varieties and breeding lines compared at three locations in 1972 is shown in Table 1. Md. 64 was the highest yielding variety with 1905 pounds of cured leaf per acre. Md. 609 was the best quality variety with an average of $77.58 per hundredweight. Several breeding lines compared very favorably with the best varieties. M872 and J-71-201 were similar to Md. 64 in yield and also gave a good dollar return per acre. These two breeding lines exhibited very good quality since they were similar to Md. 609 for dollars per hundredweight. The varieties and breeding lines ranged from 1.39% (J-71-11) to 2.19% (J-71-48) for total alkaloids. Significant variation was noted also among most of the other agronomic, physical, and chemical traits measured. Several breeding lines compared very favorably with the standard varieties for these traits.

Summary

The variety testing program was conducted at three locations in 1972. Several breeding lines with multiple disease resistance appear to have a real potential as new varieties.

Table 1. Performance of Maryland tobacco varieties and breeding lines at three locations, 1972.

Variety or breeding line	Yield per acre (lb)	Value $/A	Value $/cwt	Plant height (in.)	Leaves per plant	Internode length (in.)	Days to flower	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec/leaf)	Filling capacity (cc/g)
Md. 10	1510	1133	74.64	29.5	18.8	1.58	60.2	1.62	2.49	16.6	8.01
Md. 59	1527	1165	75.89	32.0	17.5	1.82	60.8	1.99	2.80	19.9	7.85
Md. 609	1660	1296	77.58	31.0	18.0	1.71	63.8	1.64	2.79	21.8	8.29
Md. 64	1905	1424	74.56	27.0	18.8	1.43	64.3	1.60	2.66	17.4	7.92
M872 [a/]	1927	1492	77.07	30.2	17.8	1.70	61.6	1.48	2.66	16.5	8.08
J-71-1	1825	1387	75.66	31.2	21.4	1.46	63.1	1.81	2.35	13.5	8.02
J-71-11	1367	1039	75.41	28.3	16.7	1.69	52.8	1.39	2.33	23.6	8.14
J-71-38F-1	1603	1238	77.00	29.4	17.6	1.67	58.9	2.10	2.42	13.9	7.72
J-71-48	1501	1146	76.16	28.7	17.6	1.63	62.2	2.19	2.58	19.4	7.83
J-71-201 [b/]	1894	1451	76.23	30.2	19.8	1.53	64.5	1.69	2.55	16.8	8.05
J-71-227	1815	1372	75.18	30.8	18.4	1.67	61.3	1.49	2.75	20.1	7.98
J-71-230	1608	1201	74.15	29.3	18.4	1.59	63.1	1.46	2.78	24.7	7.74
J-71-232F-1	1641	1250	75.65	29.8	17.2	1.74	60.4	1.43	2.68	20.1	7.82
B164	1480	1131	76.20	28.0	17.3	1.62	58.8	2.11	2.46	18.0	7.59
B184	1489	1149	76.77	32.3	18.8	1.71	61.2	1.78	2.84	21.0	8.28
B259	1467	1108	74.91	32.5	16.4	2.00	56.1	1.52	2.72	20.5	8.04
Mean	1639	1249	75.82	30.0	18.2	1.66	60.8	1.70	2.62	19.0	7.96
L.S.D. (0.05)	185	146	1.48	2.0	0.8	0.12	3.4	0.32	0.22	4.5	N.S.
(0.01)	249	197	1.99	2.7	1.2	0.17	4.6	0.43	0.30	6.1	N.S.
C.V. (%)	10.5	11.0	1.8	9.6	7.2	6.9	5.7	14.9	8.2	19.3	4.9

[a/] Released as Md. 872 in 1973.

[b/] Released as Md. 201 in 1973.

Tobacco Variety—Nitrogen Rate Study

M. K. Aycock, Jr. and C. G. McKee
Department of Agronomy

Purpose and Objectives

Six new Maryland tobacco varieties have been released since 1965. These varieties now are planted on about 90% of the total acreage. Basic information was needed on the reaction of these varieties to varying levels of nitrogen fertilization. Growers are now using more nitrogen per acre than in past years. Past experience has shown that some of the slower growing varieties do not need the quantity of nitrogen to produce a satisfactory crop as do some of the faster growing varieties. Thus this experiment was designed to determine the nitrogen range in which the new Maryland tobacco varieties respond the best.

Procedure

A split plot field design with 4 replications was used for this test. The main plots were nitrogen rates, 80, 100, 120 and 140 pounds per acre and the sub plots were varieties, Md. 10, Md. 59, Md. 609, Md. 64, Md. 872 and Md. 201. Factors examined were: yield per acre, value, price per cwt., days to flower, % total alkaloids and % total nitrogen.

Results

The results for the 1973 season are in Table 1. There were no significant interactions for the factors examined between nitrogen rate and variety. This indicates that for this season the varieties generally reacted the same to the increasing rates of nitrogen. There were significant differences between the varieties for all factors examined, but nitrogen rates significantly affected only yield, % total alkaloids and % total nitrogen.

Summary

The tobacco variety—nitrogen rate test will have to be conducted for several years to get meaningful results. Response to nitrogen was minimal in 1973. Acre value, price per cwt. and days to flower were not significantly affected by the relatively high rates of nitrogen used. Variety differences fell into the normal pattern with Md. 10 returning the lowest gross dollar return and Md. 64 the highest. For this season there were no significant interactions between nitrogen rate and variety for any of the factors examined.

Table 1. Tobacco variety—nitrogen rate study. 1973.

Nitrogen Rate	Yield lbs/acre	Value $/acre	Price per cwt.	Days to flower	% Total alkaloids	% Total nitrogen
80	1788	1489	83.17	54.0	1.35	1.80
100	1754	1464	83.27	53.5	1.47	1.79
120	2008	1670	83.27	54.1	1.71	2.04
140	2069	1706	82.61	54.7	1.78	2.04
L.S.D. (.05)	241	N.S.	N.S.	N.S.	.18	.14
(.01)	N.S.	N.S.	N.S.	N.S.	.26	.20
Variety						
Md. 10	1616	1331	82.29	52.3	1.51	1.82
Md. 59	1610	1348	83.74	54.4	1.66	1.98
Md. 609	1889	1588	84.05	57.6	1.68	2.02
Md. 64	2218	1833	82.69	52.9	1.49	1.82
Md. 872	2115	1756	83.06	52.9	1.53	1.97
Md. 201	1981	1637	82.65	54.4	1.58	1.90
L.S.D. (.05)	142	122	.80	1.9	.13	.12
(.01)	190	162	1.06	2.5	.17	.16

The Fertilizer Value of Broiler Litter for Topdressing Small Grains

V. A. Bandel, C. E. Rivard and F. R. Mulford
Department of Agrnomy

Purpose and Objectives

Commercial Broiler production is a very important agricultural industry in Maryland. In 1972 in dollar value it ranked higher than second-place dairy and third-place corn. However, the litter that accumulates in broiler houses is often considered a waste by-product which growers often consider a serious disposal problem. Some research data indicate that during the ten-week life span of a broiler, the accumulation of litter amounts to about 2.12 tons/1000 birds. This means that a grower producing 100,000 broilers each year would also produce about 200 tons of broiler litter which, if not disposed of, could supply much of the plant food needs for as much as 100 acres of many crops. At fall 1973 prices the total amount of nitrogen contained in the 200 tons of broiler litter is worth in excess of $5,000. Obviously, broiler litter should not be treated as a waste by-product but instead as a material that contains valuable plant nutrients. The purpose of this investigation was to determine the plant food content of litter produced under modern broiler production practices and also to determine, by field experimentation, the effectiveness of broiler litter in supplying plant nutrients when compared to equivalent amounts of chemical fertilizer.

Procedure

Blueboy wheat, seeded in the fall of 1970 on an Othello silt loam soil at the Poplar Hill Research Farm near Salisbury, was topdressed in early March, 1971, with either a commercial fertilizer or broiler litter

containing 5.0% N, 3.8% P_2O_5 and 3.8% K_2O. The litter was applied at rates to supply 0, 50, 100, 200 and 400 lbs N/acre, as well as 38, 76, 152, and 304 lbs of P_2O_5 and K_2O per acre. Nitrogen from ammonium nitrate was topdressed at 25, 50, 100, 200, and 400 lbs per acre and was supplemented with an 0-20-20 fertilizer which supplied the P_2O_5 and K_2O in about the same amounts as contained in the poultry litter. A similar test was established in the fall of 1971 adjacent to the original tests. Nitrogen, P_2O_5 and K_2O levels from broiler litter and commercial fertilizer were supplied at the same rates as the previous year. Forage yields were harvested from a portion of the plots and analyzed for N, P, and K content. Grain yields were harvested at maturity in July. Data were collected from each set of plots for two consecutive years--the treatment year and the year after treatment (residual year).

Results

Grain and forage yields of Blueboy wheat following an early spring application of equivalent amounts of N, P_2O_5, and K_2O from broiler litter and commercial fertilizer are found in Table 1 for the application years of 1971 and 1972, and in Table 2 for the year after application (1972 and 1973). Grain and forage yields were increased significantly during the application year by fertilizer and manure treatments. The commercial fertilizer increased grain yields up to the 100 lbs N/acre rate. At higher rates, grain yields were significantly reduced as a result of heavy lodging. The same type of response occurred with the forage yields.

Maximum grain yields from the broiler litter in 1971 occurred following the application of 4 tons per acre. Equivalent yields resulted from 100 lbs of N per acre from the commercial fertilizer. At the heavier

rates of broiler litter utilized in these tests, there was less lodging than occurred with equivalent rates of nitrogen from commercial fertilizer. In general, the same type of yield response was obtained in 1972 (Table 1) except that in 1972 maximum yields were obtained with lower nitrogen levels and yields in general were not as high as in 1971.

No significant response in grain or forage yields occurred the second or residual year. This indicated there was no more residual carry over of nitrogen from broiler litter than from the commercial chemical fertilizer on this soil (Table 2).

A further estimate of nutrient efficiency was obtained by measuring nutrient recovery in the Blueboy wheat forage (Tables 3 and 4). In both years it is obvious that the plant nutrients recovered from the broiler litter was not as great as from the commercial fertilizer during the early part of the growing season.

Correlating nitrogen recovered from broiler litter by Blueboy wheat forage to that recovered from commercial fertilizer resulted in correlation coefficient of 0.735 and 0.936 in 1971 and 1972, respectively. Regression coefficients of 0.38 and 0.40 for 1971 and 1972, respectively, indicated that under the conditions of these tests, for every pound of nitrogen recovered from commercial fertilizer an average of 0.39 lbs of N were recovered from the broiler litter. The relative uptake by wheat forage of phosphorus and potassium from the broiler litter appeared to be less than that from the commercial fertilizer. Correlating phosphorus recovered from broiler litter to that recovered from commercial fertilizer resulted in correlation coefficients of 0.832 and 0.930 in 1971 and 1972, respectively. Regression coefficients of 0.57 and 0.61 indicated an average efficiency of 60% for the broiler litter phosphorus as compared

to the fertilizer phosphorus. For potash, recovery correlation coefficients for 1971 and 1972 were 0.779 and 0.933, respectively. With regression coefficients of 0.62 and 0.59, an average recovery efficiency of 60% for the broiler litter potash as compared to fertilizer potash was indicated.

Summary

Nitrogen, phosphorus, and potassium recovery by Blueboy wheat was not as great from the broiler litter as it was from the chemical fertilizer early in the growing season. The efficiency of plant nutrients in the broiler litter as compared to that of the commercial fertilizer was approximately 40% for nitrogen, 60% for phosphorus, and 60% for potash. Broiler litter samples analyzed in this test varied from 2.5 to 5.2% N, from 1.6 to 4.9% P_2O_5, and from 2.0 to 5.1% K_2O. Using the above efficiency values for broiler litter, each ton of broiler litter supplied to small grain forage from 20 to 42 lbs of nitrogen, 19 to 59 lbs of P_2O_5, and 24 to 61 lbs of K_2O when topdressed in early spring.

Table 1. Yield response of Blueboy wheat to several rates of applied broiler litter and commercial fertilizer. Poplar Hill Research Farm. 1971 and 1972.

Source	Rate $N-P_2O_5-K_2O$ lbs/A	Grain Yield Bu/A	Forage Yield T/A[1/]
	1971		
Commercial Fertilizer	0- 0- 0	67.5 ab[2/]	9.0 a
	25- 19- 19	70.6 abc	10.0 a
	50- 38- 38	73.4 abc	12.0 b
	100- 77- 77	93.2 e	16.0 e
	200-154-154	77.4 bc	14.0 cd
	400-308-308	60.8 a	12.0 b
Broiler Litter	50- 38- 38 (½T/A)	72.6 abc	12.3 bc
	100- 77- 77 (1T/A)	81.0 cd	14.0 cd
	200-154-154 (2T/A)	92.2 de	13.3 bcd
	400-308-308 (4T/A)	95.4 e	14.7 de
	1972		
Commercial Fertilizer	0- 0- 0	35.6 b[2/]	5.5 a
	25- 19- 25	43.7 cd	8.8 b
	50- 38- 50	53.0 e	11.9 cd
	100- 77-100	52.9 e	13.3 d
	200-154-200	38.7 bc	12.1 cd
	400-308-400	25.2 a	12.5 d
Broiler Litter	50- 38- 50 (3/4 T/A)	48.0 de	9.2 b
	100- 77-100 (1½ T/A)	52.0 e	10.2 bc
	200-154-200 (3 T/A)	52.8 e	12.5 d
	400-308-400 (6 T/A)	47.4 de	12.8 d

1/ 30 percent dry matter.

2/ Numerical values in each column for each year are not significantly different at the 5 percent probability level when accompanied by the same letter, according to Duncan's Multiple Range Test.

Table 2. Yield response of Blueboy wheat to several rates of applied broiler litter and commercial fertilizer applied the previous year. Poplar Hill Research Farm. 1972 and 1973.

Source	Rate $N-P_2O_5-K_2O$ lbs/A	Grain Yield Bu/A	Forage Yield 1/ T/A
	1972		
Commercial Fertilizer	0- 0- 0	26.2 a 2/	5.1 a
	25- 19- 19	18.1 a	4.2 a
	50- 38- 38	17.3 a	4.9 a
	100- 77- 77	28.4 a	6.5 a
	200-154-154	24.9 a	4.6 a
	400-308-308	25.8 a	5.8 a
Broiler Litter	50- 38- 38 (½ T/A)	24.9 a	5.5 a
	100- 77- 77 (1 T/A)	26/4 a	5/4 a
	200-154-154 (2 T/A)	24.3 a	5.4 a
	400-308-308	27.5 a	6.3 a
	1973		
Commercial Fertilizer	0- 0- 0	23.0 a 2/	1.2 a
	25- 19- 25	23.1 a	1.1 a
	50- 38- 50	23.2 a	1.0 a
	100- 77-100	23.2 a	1.2 a
	200-154-200	27.2 a	1.5 a
	400-308-400	27.2 a	1.5 a
Broiler Litter	50- 38- 50 (3/4 T/A)	21.9 a	1.1 a
	100- 77-100 (1½ T/A)	24.2 a	1.2 a
	200-154-200 (3 T/A)	27.0 a	1.4 a
	400-308-400 (6 T/A)	24/8 a	1.2 a

1/ 30 percent dry matter.

2/ Numerical values in each column for each year are not significantly different from one another at the 5 percent probability level when accompanied by the same letter, according to Duncan's Multiple Range Test.

Table 3. Nutrient recovery of Blueboy wheat with several rates of applied broiler litter and commercial fertilizer. Poplar Hill Research Farm. 1971 and 1972.

Source	Rate N-P_2O_5-K_2O lbs/A	Nutrient Recovery N lbs/A	P_2O_5 lbs/A	K_2O lbs/A
	1971			
Commercial Fertilizer	0- 0- 0	42.5 a [1/]	17.7 a	67.8 a
	25- 19- 19	46.7 a	17.8 a	81.0 ab
	50- 38- 38	59.1 a	24.7 bc	110.8 bcd
	100- 77- 77	110.3 bc	39.2 d	152.6 ef
	200-154-154	134.5 c	38.7 d	158.7 f
	400-308-308	154.4 d	46.2 e	190.5 g
Broiler Litter	50- 38- 38 (½ T/A)	53.4 a	22.8 ab	98.0 bc
	100- 77- 77 (1 T/A)	67.6 a	29.8 c	120.4 cd
	200-154-154 (2 T/A)	70.1 a	29.9 c	133.6 de
	400-308-308	104.8 b	38.i d	167.8 fg
	1972			
Commercial Fertilizer	0- 0- 0	22.1 a [1/]	10.8 a	40.9 a
	25- 19- 25	34.7 ab	15.1 ab	69.7 ab
	50- 38- 50	65.0 c	21.4 bc	114.2 cd
	100- 77-100	91.7 d	27.8 cd	148.9 e
	200-154-200	141.0 e	42.0 e	217.2 g
	400-308-400	204.3 f	51.4 f	270.7 h
Broiler Litter	50- 38- 50 (3/4 T/A)	36.0 ab	16.7 ab	71.0 ab
	100- 77-100 (1½ T/A)	49.0 bc	19.6 b	84.5 bc
	200-154-200 (3 T/A)	62.0 c	29.9 d	129.9 de
	400-308-400 (6 T/A)	99.9 d	37.0 e	181.6 f

1/ Numerical values in each column for each year are not significantly different at the 5 percent probablility level when accompanied by the same letters, according to Duncan's Multiple Range Test.

Table 4. Nutrient recovery of Blueboy wheat with several rates of applied broiler litter and commercial fertilizer applied the previous year. Poplar Hill Research Farm. 1972 and 1973.

Source	Rate N-P_2O_5-K_2O lbs/A	Nutrient Recovery N lbs/A	P_2O_5 lbs/A	K_2O lbs/A
	----------1972----------			
Commercial Fertilizer	0- 0- 0	19.3 a [1/]	10.0 a	35.2 a
	25- 19- 19	17.1 a	8.2 a	28.6 a
	50- 38- 38	19.9 a	8.9 a	35.4 a
	100- 77- 77	28.1 a	12.8 a	47.1 a
	200-154-154	21.0 a	9.2 a	34.8 a
	400-308-308	23.9 a	10.3 a	43.0 a
Broiler Litter	50- 38- 38 (½ T/A)	23.7 a	11.2 a	40.4 a
	100- 77- 77 (1 T/A)	19.4 a	10 8 a	39.2 a
	200-154-154 (2 T/A)	21.7 a	10.5 a	38.8 a
	400-308-308 (4 T/A)	26.6 a	11.2 a	45.5 a
	----------1973----------			
Commercial Fertilizer	0- 0- 0	23.6 a [1/]	10.6 a	33.3 a
	25- 19- 25	20.4 a	9.3 a	28.3 a
	50- 38- 50	20.5 a	9.1 a	28.2 a
	100- 77-100	23.1 a	10.4 a	34.9 a
	200-154-200	20.5 a	8.7 a	28.9 a
	400-308-400	26.9 a	10.9 a	38.8 a
Broiler Litter	50- 38- 50(3/4 T/A)	22.0 a	22.0 a	10.1 a
	100- 77-100(1½ T/A)	24.4 a	10.8 a	35.1 a
	200-154-200(3 T/A)	26.2 a	11.8 a	39.2 a
	400-308-400(6 T/A)	23.6 a	10.4 a	34.4 a

1/ Numerical values in each column for each year are not significantly different at the 5 percent level when accompanied by the same letters, according to Duncan's Multiple Range Test.

Nitrogen Fertilization of Small Grains

V. A. Bandel
Department of Agronomy

Purpose and Objectives

Abe and Arthur are two wheat varieties recently released by the Indiana Agricultural Experiment Station and the U. S. Department of Agriculture. Both varieties have good bushel weight and straw strength, are relatively short in height, mature relatively early, and are generally resistant to mildew, leaf rust, and the hessian fly. Previous experience indicated that of the approximately 350,000 acres of small grain grown in Maryland, approximately 50% must be topdressed with from 20 to 100 lbs of nitrogen per acre if top profits and maximum yields are to be realized. This study was designed to evaluate the effects of different rates of nitrogen fertilization on lodging and grain yields of Abe and Arthur wheat.

Procedure

This test was conducted on a Mattapex silt loam and a Galestown loamy sand soil at the Poplar Hill Research Farm near Salisbury, on a Bertie silt loam soil at the Wye Institute, on a Chester loam at the Forage Research Farm near Clarksville, and on a Hagerstown silt loam soil at the Maryland Correctional Institute Farm near Hagerstown. Abe and Arthur wheat were established at these locations in the fall of 1972. In most cases, between 200 and 400 lbs per acre of 5-20-20 fertilizer was applied at seeding time. The plots were topdressed in the early spring with an additional, 0, 20, 40, 60, 80, or 100 lbs of nitrogen per acre. Observations were taken on resistance to lodging at the various nitrogen topdressing rates and grain yields were harvested at maturity in early spring.

Results

The lodging ratings are given in Table 1. A rating of one indicated no lodging, 2 and 3 indicated intermediate degrees of lodging, and a rating of 4 indicated severe lodging. In general, Abe and Arthur wheat are both about equally susceptible to lodging. With high levels of available nitrogen in the soil, both varieties can lodge severely. On the Mattapex and the Galestown soils at Poplar Hill, where apparently little available nitrogen was present in the soil, no lodging occurred even after 100 lbs of nitrogen per acre had been topdressed on the wheat. On the heavier soils at Wye Institute and the Forage Farm some lodging occurred with as little as 20 lbs of N per acre. But generally both varieties stood up fairly well with as much as 60 lbs of N per acre. On the Hagerstown silt loam, lodging was most severe due to apparent high levels of soil nitrogen released from the previous sod crop.

Grain yields are given in Table 2. In general, both varieties yielded equally well under the variable nitrogen topdressing rates. There was considerable variation between some locations. On those soils where nitrogen was a limiting factor, such as the Galestown and the Mattapex, yields were increased significantly with as much as 80 lbs of N per acre. On other soils where nitrogen was not limiting, such as the Chester and the Hagerstown, it is doubtful that nitrogen topdressing would have been recommended at more than 20 lbs of N per acre.

Summary

In general, Abe and Arthur wheat responded about equally well to nitrogen fertilization and were about equally susceptible to lodging at high nitrogen rates. Depending upon soil type and residual soil nitrogen level, Abe and Arthur wheat should respond profitably and about equally

well to applications of between 20 and 80 lbs of nitrogen per acre when topdressed in early spring.

Table 1. Lodging of Abe and Arthur wheat at various nitrogen topdressing rates on five soil types at four locations. 1973.

Variety	0	20	40	60	80	100	Ave.	LSD .05
	lb/A N							
	Lodging 1/							
Poplar Hill Farm (Mattapex si.l.)								
Abe	1	1	1	1	1	1	1	--
Arthur	1	1	1	1	1	1	1	--
Poplar Hill Farm (Galestown l.s.)								
Abe	1	1	1	1	1	1	1	--
Arthur	1	1	1	1	1	1	1	--
Wye Institute (Bertie si.l.)								
Abe	1	1	1	2	3	4	2	1
Arthur	1	2	2	2	4	4	3	1
Forage Farm (Chester l.)								
Abe	1	1	1	2	3	4	2	1
Arthur	1	1	2	2	4	4	2	1
Maryland Correctional Institute (Hagerstown si.l.)								
Abe	1	2	2	3	4	4	3	1
Arthur	1	1	2	3	4	4	3	1

1/ 1 = no lodging
4 = severe lodging

Table 2. Yield of Abe and Arthur wheat at various nitrogen topdressing rates on five soil types at four locations. 1973.

Variety	0	20	40	60	80	100	Ave.	$LSD_{.05}$
	Lb/A N							
	Bu/A							
Poplar Hill (Mattapex si.l.)								
Abe	36.6	39.5	46.0	50.4	52.1	53.8	46.4	5.4
Arthur	33.7	44.6	49.6	50.9	55.2	53.9	48.0	10.2
Poplar Hill (Galestown l.s.)								
Abe	24.9	35.5	39.6	44.8	50.3	46.9	40.3	7.4
Arthur	24.4	32.5	41.4	43.7	51.3	47.2	40.1	9.2
Wye Institute (Bertie si.l.)								
Abe	57.9	70.4	73.3	74.2	65.0	66.3	67.8	8.2
Arthur	67.4	72.4	77.2	78.2	69.5	62.4	71.2	6.5
Forage Farm (Chester l.)								
Abe	31.4	36.2	29.2	25.1	20.7	17.0	26.6	6.2
Arthur	39.6	40.4	38.0	34.4	25.6	23.5	33.6	6.6
Maryland Correctional Institute (Hagerstown si.l.)								
Abe	35.8	42.8	45.0	36.0	37.2	31.2	38.0	--
Arthur	33.8	36.1	38.3	36.0	33.6	33.6	35.2	--

No-Tillage Corn Fertilization

V. A. Bandel
Department of Agronomy

Purpose and Objectives

The no-tillage concept for corn production has caught on rapidly in Maryland, growing from an estimated 10,000 acres in 1969 to more than 250,000 acres in 1973. However, one problem with this practice is some of the unanswered questions regarding fertilization such as -- Are the fertilizer requirements of no-tillage corn the same as for conventionally grown corn? And, what is the best method of application of fertilizer materials? Field observations seem to indicate that no-tillage corn is frequently nitrogen deficient compared to conventionally tilled corn under similar fertilizing practices. However, there is little experimental data to indicate whether more or less nitrogen is required for no-tillage corn than for conventionally tilled corn. The objective of this project was to 1) compare no-tillage with conventionally tilled corn grown on well drained soils under several rates of nitorgen, 2) compare the no-tillage with conventionally tilled corn utilizing several different sources of nitrogen fertilizer, and 3) compare the no-tillage with conventionally tilled corn utilizing single and split nitrogen applications.

Procedure

Tests were initiated in the spring of 1973 at the Poplar Hill Research Farm near Salisbury, at the Wye Institute near Queenstown, and at the Plant Research Farm near College Park. Soil types were Mattapex silt loam at Poplar Hill, Bertie silt loam at Wye Institute, and Beltsville silt loam at the Plant Research Farm. At all locations a wheat cover crop established in the fall of 1972 was killed with Paraquat and atrazine plus simazine.

Pioneer 3369A corn was planted the first week of May. Nitrogen treatments were applied either prior to or after planting and were as follows:

Test #1 - No-tillage vs. conventional tillage and nitrogen rates of 0, 40, 80, 120, and 160 lbs N/acre.

Test #2 - No-tillage vs. conventional tillage with ammonium nitrate at rates of 0 and 120 lbs N/acre.

The nitrogen treatments were 120 lbs N/acre broadcast, 60 broadcast and 60 sidedressed, 30 broadcast and 90 sidedressed, and none broadcast with 120 lbs sidedressed.

Test #3 - No-tillage vs. conventional tillage with nitrogen at 0 and 120 lbs N/acre from ammonium nitrate, urea, and 30% nitrogen solution broadcast before planting plus 30% nitrogen solution at the same rate sidedressed when the corn was approximately 18 inches tall. Phosphorus and potash were applied uniformly to all plots according to soil test recommendations.

Tests 1, 2 and 3 were conducted at Poplar Hill. Tests 1 and 2 were conducted at Wye Institute and Test 1 was conducted at the Plant Research Farm. In addition to visual nitrogen deficiency ratings, silage yields were harvested from Tests 1, 2, and 3 at Poplar Hill and from Test 1 at Wye Institute. Silage samples were analyzed for nitrogen content to determine nitrogen recovery. Grain was harvested from all plots in late September and early October.

Results

Although there appeared to be more nitrogen deficiency in the no-tillage corn throughout the growing season, this observation did not hold true at harvest time. Of the six tests harvested for grain, there was no statistically significant difference in yields between tillage systems at the 5% level on three tests. Of the other three tests, conventional tillage gave

significantly higher yields in two tests and the no-tillage corn gave a significantly higher yield in the one remaining test (Tables 1, 2 and 3). When grain yields were averaged for all six tests, the no-tillage corn averaged 123.0 bu/acre and the conventional tillage corn averaged 126.6 bu/acre. These yields were not statistically different at the 5% level.

A significant response to nitrogen occurred for all tests. Maximum yields occurred at 120 lbs N/acre at Poplar Hill and Wye Institute and between 40 and 80 lbs/acre at the Plant Research Farm.

Split nitrogen applications had no significant effect upon grain yields (Table 2). In these tests, it made no difference whether the nitrogen was all applied broadcast before planting, split - part broadcast before and part sidedressed when the corn was approximately 18 inches tall, or whether the entire amount of nitrogen was sidedressed.

Nitrogen source had no significant effect upon grain yields. Ammonium nitrate, urea, and a 30% nitrogen solution all gave equivalent yields. Further, it made no difference whether the nitrogen solution was broadcast pre-plant or sidedressed when the corn was 18 inches tall.

No significant differences occurred in silage yields at the 5% level between the no-tillage and the conventional tillage systems. There was a significant increase in yields due to the nitrogen treatments. Maximum silage yields occurred with approximately 80 to 120 lbs of nitrogen per acre at Poplar Hill and at Wye Institute. Split nitrogen applications had no effect upon silage yields at Poplar Hill nor did nitrogen source (Tables 4, 5, and 6). No significant difference in nitrogen recovery between the two tillage systems occurred (Tables 7, 8, and 9).

Summary

1. Under the conditions of these tests, the yields of corn from the

no-tillage and the conventional tillage systems were not significantly different.

2. Although corn grown under both tillage systems responded to nitrogen, it appeared that at low levels of available nitrogen, conventionally tilled corn produced higher yields than the no-tillage corn for a given amount of recovered nitrogen. However, where levels of available nitrogen were adequate or higher, it appeared that the no-tillage system produced yields that were at least equivalent to those produced under the conventional tillage system.

3. Both tillage systems responded similarly to split applications of nitrogen. Under the conditions of these tests, single and split applications produced equivalent yields.

4. Both tillage systems responded similarly to nitrogen sources. Under the conditions of these tests, ammonium nitrate, urea, and 30% liquid nitrogen solution produced equivalent grain yields.

Table 1. Grain yield response of no-tillage and conventional tillage corn at various nitrogen rates at three locations. 1973.

Tillage	N (lb/A) 0	40	80	120	160	Ave.
	Bu/A					
Poplar Hill						
No-Tillage	93.2	107.8	122.0	136.9	142.2	120.4
Conventional	92.8	117.0	130.0	140.1	146.0	125.2
Ave.	93.0	112.4	126.0	138.5	144.1	
LSD.05 = 12.4 Bu.						
Wye Institute						
No-Tillage	92.9	117.2	123.0	136.2	141.8	122.2
Conventional	112.2	137.7	133.6	151.2	138.3	134.6
Ave.	102.6	127.5	128.2	143.7	140.1	
LSD.05 = 13.8 Bu.						
Plant Research Farm						
No-Tillage	54.1	99.6	116.5	102.4	119.0	98.3
Conventional	67.1	75.0	86.6	96.3	110.6	87.1
Ave.	60.6	87.3	101.6	99.3	114.8	
LSD.05 = 21.6 Bu.						

* Means for tillage practice significant at 5% level.

Table 2. Grain yield response of no-tillage and conventional tillage corn following single and split application of 120 lb N/A. 1973.

Tillage	N (lb/A) Broadcast and/or Sidedressed: Check	120 Br. 0 S.D.	60 Br. 60 S.D.	30 Br. 90 S.D.	0 Br. 120 S.D.	Ave.
	Bu/A (15.5% H_2O)					
Poplar Hill						
No-Tillage	79.5	132.0	142.3	139.2	140.4	126.7
Conventional	93.6	136.7	129.4	139.7	123.2	124.5
Ave.	86.5	134.4	135.8	139.4	131.8	
LSD.05 = 11.2 Bu.						
Wye Institute						
No-Tillage	76.8	145.1	151.2	140.9	136.1	130.0*
Conventional	76.8	129.9	133.8	128.9	140.3	121.9
Ave.	76.8	137.5	142.5	134.9	138.2	
LSD.05 = 14.6 Bu.						

* Means for tillage practice significant at 5% level.

Table 3. Grain yield response of no-tillage and conventional tillage corn following application of 120 lb N/A from three sources. 1973.

Tillage	N Source: Check	A.N. 1/	Urea 1/	30% N Sol. 1/	30% N Sol. 2/	Ave.
	Bu/A					
			Poplar Hill			
No-Tillage	77.4	130.1	124.7	132.0	145.0	121.8*
Conventional	86.2	137.8	139.3	147.4	139.5	130.0
Ave.	81.8	134.0	132.0	139.7	142.2	
	LSD.05 = 8.2 Bu.					

1/ Broadcast pre-plant.
2/ Sidedressed when 18 inches tall.
* Means for tillage practice significant at 5% level.

Table 4. Silage yield response of no-tillage and conventional tillage corn at various nitrogen rates at two locations. 1973.

Tillage	N (lb/A): 0	40	80	120	160	Ave.
	Tons/A (30% D.M.)					
			Poplar Hill			
No-Tillage	14.6	17.4	19.5	22.6	23.2	19.4
Conventional	16.9	20.6	23.4	21.9	25.2	21.6
Ave.	15.7	19.0	21.4	22.3	24.2	
	LSD.05 = 2.3 Tons					
			Wye Institute			
No-Tillage	18.8	22.8	24.6	23.4	27.4	23.4
Conventional	19.7	22.4	23.5	26.6	25.7	23.6
Ave.	19.3	22.6	24.1	25.0	26.6	
	LSD.05 = 2.6 Tons					

Table 5. Silage yield response of no-tillage and conventional tillage corn following single and split application of 120 lb N/A. 1973.

Tillage	Check	120 Br. 0 S.D.	60 Br. 60 S.D.	30 Br. 90 S.D.	0 Br. 120 S.D.	Ave.
	N (lb/A) Broadcast and/or Sidedressed					
	Tons/A (30% D.M.)					
	Poplar Hill					
No-Tillage	13.6	20.0	20.7	21.3	22.0	19.6
Conventional	14.9	23.2	22.2	20.8	23.2	20.9
Ave.	14.3	21.6	21.4	21.1	22.6	
	LSD.05 = 3.2 Tons					

Table 6. Silage yield response of no-tillage and conventional tillage corn following application of 120 lb N/A from three sources. 1973.

Tillage	Check	A.N.[1/]	Urea[1/]	30% N Sol.[1/]	30% N Sol.[2/]	Ave.
	N Source					
	Tons/A (30% D.M.)					
	Poplar Hill					
No-Tillage	13.4	22.0	19.6	20.7	22.4	19.6
Conventional	15.0	22.5	19.4	21.3	24.5	20.5
Ave.	14.2	22.2	19.5	21.0	23.4	
	LSD.05 = 2.2 Tons					

1/ Broadcast pre-plant.
2/ Sidedressed when 18 inches tall.

Table 7. Nitrogen recovery by no-tillage and conventional tillage corn at various nitrogen rates at three locations. 1973.

Tillage	N (lb/A) 0	40	80	120	160	Ave.
	lb/A					
Poplar Hill						
No-Tillage	66.1	91.5	100.2	121.8	142.5	104.4
Conventional	89.1	97.0	120.0	113.4	163.2	116.5
Ave.	77.6	94.3	110.1	117.6	152.8	
	LSD.05 = 21.7 lb.					
Wye Institute						
No-Tillage	93.2	130.0	147.9	141.4	176.6	137.8
Conventional	110.4	130.2	135.9	168.0	174.1	143.7
Ave.	101.8	130.1	141.9	154.7	175.3	
	LSD.05 = 26.2 lb.					

Table 8. Nitrogen recovery by no-tillage and conventional tillage corn following single and split application of 120 lb N/A. 1973.

Tillage	N (lb/A Broadcast and/or Sidedressed) Check	120 Br. 0 S.D.	60 Br. 60 S.D.	30 Br. 90 S.D.	0 Br. 120 S.D.	Ave.
	lbs/A					
Poplar Hill						
No-Tillage	70.8	128.8	127.0	140.8	144.3	122.4
Conventional	73.8	159.8	141.8	116.5	154.2	129.2
Ave.	72.3	144.3	134.4	128.7	149.2	
	LSD.05 = 21.3 lbs.					

Table 9. Nitrogen recovery by no-tillage and conventional tillage corn following application of 120 lb N/A from three sources. 1973.

Tillage	N Source					
	Check	A.N.[1/]	Urea[1/]	30% N Sol.[1/]	30% N Sol[2/]	Ave.
	Lbs/A					
			Poplar Hill			
No-Tillage	68.7	125.8	116.0	113.8	131.9	111.2
Conventional	76.8	140.9	115.7	138.7	153.3	125.1
Ave.	72.7	133.4	115.8	126.2	142.6	
	LSD.05 = 24.2 lbs.					

1/ Broadcast pre-plant.
2/ Sidedressed when 18 inches tall.

Sulfur Fertilization

V. A. Bandel
Department of Agronomy

Purpose and Objectives

In recent years, some concern has developed regarding possible sulfur deficiencies on certain Maryland soils. Some of the reasons for the development of this concern include:

1. The trend toward the use of higher analysis fertilizers which contain less sulfur as an impurity.

2. The trend away from the use of high sulfur fuels, thus reducing the amount of sulfur dioxide available as an atmospheric source of plant nutrient sulfur.

3. Higher crop yields, particularly in a monoculture situation which places a heavier drain upon sulfur from the soil.

The objective of this project was to determine if corn would respond to sulfur fertilization when grown on soils which had received little or no known sulfur fertilization in recent years.

Procedure

Based upon work conducted in Maryland in 1971 and 1972, which indicated that corn ear leaf sulfur levels were sometimes in the deficiency range and that also the nitrogen to sulfur ratios sometimes were wider than generally considered best for ruminants, it was decided that corn sulfur fertilization tests should be continued in 1973. Therefore, field tests were established in 1973 at ten locations throughout Maryland. The test locations were selected from fields which had reportedly received little or no sulfur fertilization for the past several years. Sulfur was applied at rates of 0, 50, and 200 lbs/acre from gypsum in the early spring.

Sulfur was also applied at a rate of 50 lbs/acre from potassium sulfate. Whole corn plant samples were obtained when the plants were approximately 18 to 24 inches in height. Corn ear leaf samples were collected at tasselling. All plant samples were analyzed for nitrogen and sulfur. Grain yields were harvested in September. The location and soil type for each test are given in Table 1.

Results

Grain yields obtained at each location are given in Table 2. A statistically significant response occurred at location number 3 (Wicomico County). However, this response could not be related to sulfur treatment and was therefore, due to soil variability. At locations 1 and 2 (Worcester County), 6 (Talbot County), and 8 (Cecil County) trends were apparent which indicated possible responses to sulfur treatment. Tests will be continued at some of these locations in 1974.

Sulfur content of the whole young corn plants is given in Table 3. Sulfur fertilization resulted in a significant increase in sulfur content at two locations - 4 (Dorchester County) and 9 (Carroll County). These increases occurred only at the 200 lb/acre sulfur rate. At several other locations, interesting trends occurred, which although statistically not significant, indicated a possible increase in sulfur uptake due to sulfur fertilization at this early stage of growth.

The nitrogen to sulfur ratio of whole young corn plants is given in Table 4. Again, a statistically significant reduction in nitrogen to sulfur ratio occurred at only two locations -- 4 (Dorchester County) and 10 (Allegany County). Similar to the sulfur level in the whole young plants, a number of other locations indicated possible trends from high to low nitrogen to sulfur ratios with increasing sulfur fertilization rates.

Sulfur content of corn ear leaves at tasselling is given in Table 5. At this stage of growth, a statistically significant increase in the ear leaf sulfur levels occurred at location 1 (Worcester County) and location 10 (Allegany County).

The nitrogen to sulfur ratios of the corn ear leaves at tasselling is given in Table 6. At this stage of growth, there is a statistically significant reduction in nitrogen to sulfur ratio of the corn ear leaf with increasing sulfur fertilization rate at location 1 (Worcester County). Again, some of the other locations indicated a possible nitrogen to sulfur ratio reduction, particularly at the high 200 lb S/acre rate.

Summary

In general, no statistically significant yield response to sulfur fertilization occurred on corn in the 1973 tests. Statistically non-significant trends occurred at some locations, indicating a possible yield response. Similarly, sulfur levels of the whole young plant, as well as of the ear leaves, were increased with increasing sulfur fertilization at some locations. The nitrogen to sulfur ratios were significantly reduced at two locations for the whole young plant and at one location for the ear leaf. Similar trends, although statistically non-significant, appeared at certain other locations.

In general, it appears that although sulfur levels appeared to be low in many of the corn fields tested, little or no response was obtained from sulfur fertilization. Sulfur fertilization resulted in some increased sulfur uptake and subsequent narrowing of the nitrogen to sulfur ratio, which may be important in improved feed quality. This work will be continued in 1974 on a limited number of locations.

Table 1. Locations of corn sulfur fertilization tests conducted in Maryland. 1973.

No.	County	Farmer	Soil Type
1	Worcester	Dave Brunning	Matapeake fine sandy loam
2	Worcester	Bill Pusey	Matapeake fine sandy loam
3	Wicomico	Lay Philips	Othello silt loam
4	Dorchester	Fred Eberspacher	Matapeake fine sandy loam
5	Dorchester	Roland Webster	Matapeake silt loam
6	Talbot	Hazel Clarke	Othello silt loam
7	Kent	Olin Davis	Sassafras loam
8	Cecil	Robert Miller	Butlertown silt loam
9	Carroll	Rash Bros.	Glenelg loam
10	Allegany	Jack Miltonberger	Pope silt loam

Table 2. Yield response of corn to sulfur fertilization. 1973.

Location	S-lb/A				
	0	50 1/	50 2/	200 2/	LSD.05 3/
	Bu/A 4/				
1	124.6	139.7	139.5	135.4	N.S.
2	102.4	106.7	112.2	123.5	N.S.
3	155.2	148.1	147.2	158.6	8.3
4	135.4	139.7	143.5	133.4	N.S.
5	162.3	160.6	154.8	158.2	N.S.
6	90.1	112.8	109.8	100.6	N.S.
7	107.4	96.5	100.2	108.8	N.S.
8	118.7	122.8	106.2	132.6	N.S.
9	64.4	58.8	90.5	52.4	N.S.
10	143.4	131.5	148.6	134.2	N.S.
Ave.	120.4	121.7	125.2	123.8	

1/ S from potassium sulfate.
2/ S from gypsum.
3/ Least significant difference at 5% probability level.
4/ Grain @ 15.5% H_2O.

Table 3. Sulfur content of whole young corn plants (approximately 18 to 24 inches tall) under three rates and two sources of sulfur. 1973.

Location	S-lb/A 0	50[1/]	50[2/]	200[2/]	LSD.05[3/]
	% S				
1	0.11	0.12	0.15	0.16	N.S.
2	0.12	0.12	0.13	0.13	N.S.
3	0.10	0.10	0.12	0.10	N.S.
4	0.08	0.08	0.08	0.12	0.03
5	0.09	0.09	0.10	0.10	N.S.
6	0.12	0.12	0.12	0.13	N.S.
7	0.11	0.11	0.11	0.12	N.S.
8	0.10	0.10	0.11	0.11	N.S.
9	0.12	0.13	0.13	0.15	0.02
10	0.13	0.13	0.13	0.15	N.S.
Ave.	0.11	0.11	0.12	0.13	

1/ S from potassium sulfate.
2/ S from gypsum.
3/ Least significant difference at 5% probability level.

Table 4. Nitrogen to sulfur (N/S) ratio of whole young corn plants (approximately 18 to 24 inches tall) under three rates and two sources of sulfur. 1973.

Location	S-lb/A 0	50[1/]	50[2/]	200[2/]	LSD.05[3/]
	N/S				
1	32.0	31.5	24.7	21.4	N.S.
2	32.0	27.6	27.7	25.1	N.S.
3	38.6	37.0	34.2	41.2	N.S.
4	35.6	35.9	34.1	24.1	8.5
5	34.4	36.7	32.8	31.9	N.S.
6	31.4	30.1	32.8	29.7	N.S.
7	31.8	32.7	30.6	29.4	N.S.
8	35.5	33.9	31.7	31.8	N.S.
9	27.4	26.4	26.4	21.4	N.S.
10	29.7	24.2	25.6	23.2	4.3
Ave.	32.8	31.6	30.1	27.9	

1/ S from potassium sulfate.
2/ S from gypsum.
3/ Least significant difference at 5% probability level.

Table 5. Sulfur content of corn ear leaves at tasselling under three rates and two sources of sulfur. 1973.

Location	S-lb/A 0	50[1]	50[2]	200[2]	LSD.05[3]
	% S				
1	0.15	0.18	0.20	0.26	0.03
2	0.17	0.17	0.16	0.17	N.S.
3	0.15	0.14	0.15	0.15	N.S.
4	0.15	0.16	0.15	0.16	N.S.
5	0.13	0.13	0.14	0.15	N.S.
6	0.15	0.16	0.16	0.18	N.S.
7	0.14	0.16	0.14	0.17	N.S.
8	0.16	0.16	0.17	0.17	N.S.
9	0.12	0.12	0.12	0.14	N.S.
10	0.15	0.17	0.16	0.20	0.02
Ave.	0.15	0.16	0.16	0.18	

1/ S from potassium sulfate.
2/ S from gypsum.
3/ Least significant difference at 5% probability level.

Table 6. Nitrogen to sulfur (N/S) ratio of corn ear leaves at tasselling under three rates and two sources of sulfur. 1973.

Location	S-lb/A 0	50[1]	50[2]	200[2]	LSD.05[3]
	N/S				
1	19.1	17.0	16.2	11.3	3.3
2	14.7	15.6	15.1	14.3	N.S.
3	23.9	24.7	25.4	22.4	N.S.
4	20.9	19.3	22.8	19.6	N.S.
5	23.0	21.1	22.7	21.8	N.S.
6	19.3	18.8	18.6	17.0	N.S.
7	22.7	20.8	22.7	19.3	N.S.
8	17.8	18.6	18.3	18.2	N.S.
9	17.3	16.2	17.2	14.3	N.S.
10	16.2	14.2	15.7	12.7	N.S.
Ave.	19.5	18.6	19.5	17.1	

1/ S from potassium sulfate.
2/ S from gypsum.
3/ Least significant difference at 5% probability level.

Zinc Fertilization of Corn and Soybeans

V. A. Bandel and C. E. Rivard
Department of Agronomy

Purpose and Objectives

Zinc deficiency of corn occurs on a relatively small acreage in Maryland. However, zinc deficiency can seriously reduce corn yields in certain localized areas. Because the problem is serious for the farmer when it does occur, and since much publicity has been given to the few cases where a response to zinc fertilization has occurred, many growers are aware of potential zinc deficiency in corn and often applied zinc where it is not needed. In cases where unnecessary zinc fertilizer applications are made, there is a potential problem of zinc build-up to toxic levels in the soil, particularly for the more zinc sensitive crops such as soybeans which often follow corn. The objectives of this project were to compare the effectiveness of several rates of row-applied zinc fertilizer on corn yields and zinc content of the plant when applied to several different soil types. Also, the effects of zinc applied the previous year on corn and syybean yields and plant zinc contents were studied.

Procedure

In 1973, zinc tests on corn were conducted at three locations-- two in Worcester County and one in Howard County. In Worcester County, sites were selected in which the soils were known to be low in zinc and had previously resulted in corn zinc deficiency symptoms. On the Othello soil the residual effects were observed from zinc which had been applied to corn in 1972. On the Matapeake soil, zinc was applied to corn in 1973. In Howard County, the site treated with zinc in 1972, on which a soil test indicated a satisfactory zinc level before treatment, and on which a zinc

had not been detected previously, was studied for any possible effect the second year after treatment. At a fourth site in Worcester County on a Matapeake soil, on which corn had been grown in 1972 following variable zinc application rates, soybeans were planted in 1973 and observed for any response due to the residual zinc in the soil.

Soil test information for each site is given in Table 1. On the plot areas in their second or residual year, the crop was planted by the farmer. No additional treatments were applied. The plot area at the Worcester Vocational Center on which zinc was applied in the corn row was seeded with a two-row International corn planter equipped with an eight-hose squeeze pump. An 11-37-0 fertilizer solution containing various amounts of zinc was placed approximately two inches to the side and two inches below the seed at planting time. Zinc oxide was applied at rates of 0, 2, 4, 8, and 12 lbs of zinc per acre. At a rate of 400 lbs per acre of 11-37-0, this required solutions containing 0.5, 1, 2, and 3% zinc. A Geigy chelated zinc was also applied at a rate of 0.3 lbs of zinc per acre. Observations of plant growth were made during the season. Corn ear leaf samples were collected at the tasselling stage and the uppermost fully developed soybean leaves were collected at blossom stage for determination of zinc content. Grain yields were harvested and measured in September.

Results

An early corn response to the zinc treatments applied in 1973 occurred on the Matapeake soil at the Worcester Vocational Center. This response was observed only during the early stages of growth. By tasselling, most of the differences had disappeared. No significant response to zinc treatment could be detected by zinc content of the plant (Table 2) nor did any significant yield response occur (Table 5). Corn grown where zinc fertilizer had been applied the previous year similarly showed no increase in

zinc uptake (Table 3 and 4). Grain yields on the Othello and the Chester soils the second year after treatment were not influenced by zinc treatment (Table 5). Soybeans grown on a Matapeake soil at the Worcester Vocational Center which had been treated with variable zinc rates in 1972, demonstrated a significant increase in zinc content of the upper fully developed trifoliate leaves. Grain yields were not effected by the previous zinc treatments (Table 6).

Summary

No response either in zinc content of the corn plant or in yields occurred in 1973 due to zinc fertilizer applied either in 1972 or in 1973 in spite of the fact that some of these soils indicated a very low soil test level of available zinc. Soybean yields were not effected by zinc applications as high as 12 lbs per acre on corn the previous year. Zinc content of the plant, however, was significantly increased by these treatments. This work will be continued in 1974 on both corn and soybeans with some new locations being established and the old ones being observed for residual carryover effects in the 1974 crop.

Table 1. Location, soil series and fertility level of 1973 zinc test sites.

County	Farm	Soil Series	pH	P_2O_5	Zinc
				-----lb/A-----	
Worcester	Cherrix	Othello	6.7	100 M	0.6
Worcester[1/]	Vocational Center	Matapeake	7.0	150 H	1.0
Worcester[2/]	Vocational Center	Matapeake	7.0	95 M	0.7
Howard	Forage Research	Chester	6.7	115 M	2.4

1/ Soybean test
2/ Corn test

Table 2. Zinc content of whole young corn plants (18 to 24" tall) and ear leaves in 1973 following variable zinc application in 1973 at Worcester Vocational Center.

Plant Part	Row Zinc (lb/A)						
	0	0.3	2	4	8	12	LSD.05
	ppm						
Whole plant	20	16	16	24	18	20	---
Ear leaf	12	12	10	12	12	13	---

Table 3. Zinc content of whole young corn plants (18 to 24" tall) in 1973 following variable zinc applications in 1972.

Soil Series	Row Zinc (lbs/A)							
	0	0.3	1	2	3	8	12	LSD.05
	ppm							
Othello	29	23	28	30	29	29	28	--
Chester	30	24	27	33	24	24	22	--
Ave.	30	24	28	32	26	26	25	--

Table 4. Zinc content of corn ear leaves in 1973 following variable zinc applications in 1972.

Soil Series	Row Zinc (lb/A) 0	0.3	1	2	4	8	12	LSD.05
	ppm							
Othello	15	14	16	17	17	18	17	--
Chester	22	18	22	22	20	20	18	--
Ave.	18	16	19	20	18	19	18	--

Table 5. Grain yield response of corn to variable zinc treatments. 1973.

Soil Series	Zinc Applied 1972 Row Zinc (lb/A) 0	0.3	1	2	4	8	12	LSD.05
	Bu/A							
Othello	133.0	142.9	136.0	118.9	114.7	141.6	134.1	--
Chester	117.8	119.0	116.3	117.6	133.1	120.3	133.4	--
Ave.								
	Zinc Applied 1973							
Matapeake	113.1	126.8	--	117.2	117.6	132.4	118.0	--

Table 6. Response of soybeans to variable zinc treatments applied to corn on a Matapeake fine sandy loam in 1972. 1973.

	Row Zinc (lb/A) 0	0.3	2	4	8	12	LSD.05
Zn (ppm) 1/	22	24	29	34	39	43	5
Yield (bu/A)	39.9	42.9	41.8	41.4	40.8	43.1	---

1/ Upper fully developed leaf at blossom.

Control of Established Johnsongrass In Corn With Thiocarbamate Herbicides

G. W. Burt
Department of Agronomy

Purpose and Objectives

Laboratory and field work by the author has shown that the thiocarbamate herbicides offer a practical solution for controlling johnsongrass in corn. The present experiment was conducted to (a) determine the effectiveness of lower rates of EPTC than used in previous experiments; (b) determine the influence of planting date on johnsongrass control; (c) determine if data from previous years and on different soil types was representative and (d) determine the effect of cultivation on herbicide effectiveness.

Procedures

A johnsongrass infestation was selected for the experimental area near Cordova, Maryland. This area was infested with johnsongrass for more than 10 years. During the last ten years, the area was not used agriculturally but was periodically mowed and spread with poultry manure. The soil was rated high for magnesium, very high for phosphate and medium for potassium by the soil testing service of the University of Maryland. The dominant soil was a Galestown loamy sand with a pH of 5.6 and 1.5% organic matter.

This experiment was conducted to give maximum advantage to johnsongrass growth over corn production. This was done in order to give the herbicides, under study, the most difficult test possible. In this regard, a freshly plowed field was lightly disked before herbicide incorporation to a depth of 3 inches with a rototiller. Herbicides (Table 1) were applied at 30

gallons per acre and immediately incorporated on the same day of planting (May 11 and June 3, Table 1). These herbicides were formulated with a protectant (N, N-diallyl-2,2-dichloroacetamide) to prevent corn injury. On May 11 and June 3, 1973, Pioneer, var. 3334 A, was planted with 300 lb/A of 5-10-10. Corn was not cultivated throughout the season (except for one treatment, Table 1) in order to give maximum pressure on the herbicide treatment. One treatment was, however, cultivated on 6/21/73 (Table 1).

Plots were replicated four times in a randomized block design. Plots were 10 by 30 feet with 30 inch row spacing. Visual ratings of percentage johnsongrass control were made several times throughout the season. Corn harvest for 26 ft of a center row was on September 29, 1973. Stand was estimated at 10,000 plants per acre for the June 3 planting date and 17,000 plants per acre for the May 11 planting date.

Results

Application of thiocarbamate herbicides was once again shown to be effective in controlling established johnsongrass in corn (Table 1). Yield of corn was 3 bu/A without any weed control and 81 bu/A in the hand weeded control. According to corn yields, the best herbicide treatments were EPTC at 6 and 8 lb/A and vernolate at 8 lb/A. Corn yield from EPTC at 4 lb/A plus one cultivation also was 75% of the hand weeded control. Yield on the early corn planting (May 11) was generally higher than for the June 3 planting probably because this planting somewhat avoided a late summer drought and because a higher population density of corn was used in the early planting. No significant differences existed between early and late planting dates in yield or johnsongrass control for any herbicide treatment.

Summary

Effective control of established johnsongrass was obtained by the use of thiocarbamate herbicides. EPTC was the most effective and con-

sidering cost 6 lb/A would most probably be the preferred rate. EPTC at 4 lb/A and one cultivation also gave satisfactory control. At the end of the season there was no difference in johnsongrass control or yield of corn between treatments applied on May 11 and June 3.

Table 1. Control of Established Johnsongrass in Corn with Thiocarbamate Herbicides[a]

Herbicide[b]	Rate of Application lb/A	Normal rate equivalent of thiocarbamate	Planting Date	Johnsongrass Control (%) 6/20/73	8/8/73	Corn yield[c] (Bu/A)
Control	---	---	June 3	0 e	0 c	3 e
Control hand weeded	---	---	June 3	0 e	100 a	81 ab
EPTC	4	1	June 3	73 ab	73 bc	47 abcd
EPTC	4 + cultivation	1	June 3	70 abc	87 bc	59 abcd
EPTC	6	2	June 3	83 a	78 bc	72 abcd
EPTC	8	3	June 3	85 a	73 bc	59 abcd
EPTC	4	1	May 11	36 d	63 b	48 abcd
EPTC	6	2	May 11	53 bcd	76 bc	75 abc
EPTC	8	3	May 11	63 abc	80 bc	82 a
vernolate	4	1	June 3	30 d	63 b	39 bcd
vernolate	6	2	June 3	76 ab	67 bc	38 cd
vernolate	8	3	June 3	86 a	80 bc	58 bcd
butylate	6	1	June 3	43 cd	63 b	32 d

[a]Values not followed by the same letter in the same column are significantly different at the 5% level according to the Student-Newman-Keul's test.

[b]EPTC, butylate and vernolate were formulated and applied with the protectant, N,N diallyl-2,2 dichloracetamide

[c]Harvested from one 26 ft row on 9/29/73. Yields are presented as 15½% moisture, U. S. Grade No. 2. Corn populations were 17,000 plants for May 11 planting and 10,000 for June 3 planting.

Control of Established Johnsongrass in Soybeans with Toluidine Herbicides After Two Consecutive Years

G. W. Burt
Department of Agronomy

Purpose and Objectives

Trifluralin is known to control established johnsongrass when applied for two consecutive years at 2 times its normally recommended rates. The present study was conducted to determine if several experimental compounds similar to trifluralin could also control established johnsongrass. The results presented in this report were taken during the second consecutive years of application of several experimental toluidine herbicides and the registered toluidine herbicides, nitralin and trifluralin.

Procedures

A johnsongrass infestation was selected for the experimental area near Cordova, Maryland. This area was infested with johnsongrass for more than ten years. During the last ten years the area was not used agriculturally but was periodically mowed and spread with poultry manure. The soil was rated high for magnesium, very high for phosphate and medium for potassium by the soil testing service of the University of Maryland. The dominant soils were Sassafras and Galestown sandy loam with a pH of 5.6 and 2.5% organic matter.

Preemergence herbicides (Table 1) were applied at 30 gallons per acre and immediately incorporated, on June 3, 1973, and soybeans, var. Wye, were planted the same day. No cultivation was performed during this season. Plots were 30 by 10 ft with 30 inch row spacing and were replicated four times in a randomized block design. Visual ratings of johnsongrass control and soybean injury were made several times throughout the season. Soybeans were harvested from 20 feet of the two center rows of each plot on November 7, 1973.

Results

After two consecutive years of application, trifluralin, nitralin, profluralin and fluchoralin gave satisfactory johnsongrass control. Since no cultivation was performed in 1973 the results are not as good as might have been expected. No herbicide gave more than 85% control at the end of the season. Two consecutive years of application of dinitramine and A 820 gave poor results although control was statistically better than the control. Two years application of MBR 8251 gave essentially no johnsongrass control. One year application of AC 92390 also gave no control of johnsongrass. AN 56477 and SD 27695 were not reapplied in 1973 because these chemicals were not available. The results with these chemicals when observed in 1972 were also not satisfactory. A good correlation existed between johnsongrass control and the yield of soybeans. No injury was noted for any treatment at anytime throughout the growing season.

Summary

Trifluralin, nitralin, profluralin and fluchoralin gave good johnsongrass control in field trials. AC 92390, dinitramine, A 820, MBR 8251 and SD 27695 did not give satisfactory control of established johnsongrass in this study.

Table 1. Control of Johnsongrass in Soybeans with Toluidine Herbicides[a]

Herbicide		Rate lb/A		Johnsongrass Control (%) 6/26/73	Johnsongrass Control (%) 9/17/73	Soybean Yield (Bu/A)
1972	1973	1972	1973			
Control	Control	----	----	0 c	0 d	2 e
Trifluralin	Trifluralin	1.0	1.0	75 a	80 a	48 ab
Control	AC 92390	----	3.0	40 b	0 d	23 cd
Nitralin	Nitralin	1.5	1.5	83 a	85 a	52 ab
Dinitramine	Dinitramine	0.66	0.66	75 a	50 b	33 bc
AN56477	Control	2.0	----	30 b	33 bc	13 de
Profluralin	Profluralin	2.0	2.0	85 a	85 a	57 a
A 820	A 820	2.5	2.0	65 a	53 b	33 bc
Fluchoralin	Fluchoralin	1.5	1.5	80 a	70 a	38 abc
MBR 8251	MBR 9251	4.0	4.0	23 b	10 cd	4 de
SD 27695	Control	2.0	----	0 c	13 cd	2 e
SD 27695	Control	4.0	----	0 c	20 cd	7 de

[a]means within columns followed by the same letter do not differ at the 5% level of significance according to Student-Newman-Keul's test.

Control of Johnsongrass in Corn With Thiocarbamate Herbicides After Two Consecutive Years

G. W. Burt
Department of Agronomy

Laboratory and field work by the author has indicated that several thiocarbamate herbicides can control rhizomatous johnsongrass. This can be accomplished without significant corn injury with the addition of a protectant (N, N-diallyl-2,2-dichloracetamide). This report presents results of johnsongrass control and corn yields in 1973 for plots treated with identical amounts of thiocarbamate herbicides in the spring of 1972 and 1973. Glyphosate postdirected treatments in 1972 were not repeated in 1973. Weed control in 1973 caused by the butylate preplant incorporated + glyphosate postdirected treatments would be, therefore, a residual effect from the 1972 application.

Procedures

A johnsongrass infestation was selected for the experimental area near Cordova, Maryland. This area was 100% infested with johnsongrass and had been so for more than 10 years. During the last ten years the area was not used agriculturally but was periodically mowed and spread with poultry manure. The soil was rated high for magnesium, very high for phosphate and medium for potassium by the soil testing service of the University of Maryland. The dominant soil was a Sassafras sandy loam with a pH of 5.6 and 2.5% organic matter.

This experiment was conducted to give maximum advantage to johnsongrass growth over corn production. This was done in order to give the herbicides under study the most difficult test possible. In this regard a freshly plowed field was lightly disked before herbicide incorporation to a depth of 3 inches with a rototiller. Herbicides (Table 1) were applied at 30

gallons per acre and immediately incorporated. These herbicides were commercially formulated with a protectant (N, N-diallyl-2,2-dichloroacetamide) to prevent corn injury. On June 3, 1973, Corn, Pioneer var. 3334 A, was planted with 300 lb/A of 5-10-10. Corn was not cultivated throughout the season.

Plots were replicated four times in a randomized block design. Plot size was 10 by 30 with 30 inch row spacing. Visual ratings of percent johnsongrass control were made several times throughout the season. Corn harvest for 26 ft of a center row was on September 29, 1973. Stand was estimated at 11,600 plants per acre at this time.

Results

Results after two consecutive years of thiocarbamate application confirm the hypothesis that the thiocarbamate herbicides are useful for controlling johnsongrass in corn. With no chemicals for johnsongrass control and no cultivation no corn grain was harvested. Treatment of butylate, vernolate or EPTC for 2 consecutive years resulted in corn yields up to 71 bu/A and controlled johnsongrass up to 90%. Among herbicides butylate at 4 lb/A was the only treatment which was significantly different from any other treatment. The higher rates of all three thiocarbamate herbicides gave adequate control when used 2 years consecutively. Butylate, preplant incorporated + glyphosate postdirected treatments in 1972 resulted in adequate corn yield and johnsongrass control in 1973. Corn injury caused by glyphosate in 1972, however, makes this treatment unsatisfactory.

Summary

Thiocarbamate herbicides were evaluated in the same location for 2 consecutive years. All three herbicides (butylate, vernolate, & EPTC) adequately controlled johnsongrass with rates used in this study. Butylate, + glyphosate applied in the previous year also had some residual effect.

Table 1. Control of Johnsongrass in corn after two consecutive years of thiocarbamate treatment[a]

Herbicide		Rate of Application lb/A		Normal rate equivalent of thiocarbamate	Johnsongrass Control (%)		Corn Yield (Bu/A)
1972	1973	1972	1973		6/20/73	8/8/73	
Control	Control	----	----	----	0 d	0 e	0 a
Butylate	Butylate	4	4	1	38 c	55 d	37 b
Butylate	Butylate	8	8	2	70 ab	80 ab	55 c
Butylate	Butylate	12	12	3	83 a	90 a	71 c
Vernolate	Vernolate	6	6	2	73 ab	70 bc	53 c
Vernolate	Vernolate	9	9	3	88 a	85 ab	62 c
EPTC	EPTC	8	8	2	83 a	88 a	54 c
EPTC	EPTC	12	12	3	85 a	85 ab	71 c
Butylate+ Glyphosate	-----	4+½	---	1	60 b	63 cd	54 c
Butylate+ Glyphosate	-----	4+1	---	1	57 b	78 ab	60 c
Butylate+ Glyphosate	-----	8+½	---	2	83 a	90 a	54 c
Butylate+ Glyphosate	-----	8+1	---	2	78 a	85 ab	60 c

[a]Values not followed by the same letter in the same column are significantly different at the 5% level according to the Student-Newman-Keul's test.

Control of Johnsongrass in Soybeans After Two Years of Treatment with Trifluralin, Glyphosate and Alachlor

G. W. Burt
Department of Agronomy

Purpose and Objectives

Trifluralin is known to control johnsongrass when applied at higher than normally recommended rates. The present study was conducted to determine the effectiveness of various rates of trifluralin and other herbicides which have a potential in johnsongrass control in soybeans. The results presented in this years report are after two consecutive years of herbicide application.

Procedures

A johnsongrass infestation was selected for the experimental area near Cordova, Maryland. This area was infested with johnsongrass for more than 10 years. During the last ten years the area was not used agriculturally but was periodically mowed and spread with poultry manure. The soil was rated high for magnesium, very high for phosphate and medium for potassium by the soil testing service of the University of Maryland. The soils were Sassafras and Galestown sandy loam with a pH of 5.6 and 2.5% organic matter.

Preemergence herbicides (Table 1) were applied at 30 gallons per acre and immediately incorporated on June 3, 1973 and planted to soybeans, var. Wye, on the same day. Higher rates of trifluralin were used in 1973 than 1972 because it was realized that the high organic matter content required this increase in rates. No cultivation was performed during the season. In the previous year, glyphosate was postdirected on July 10, 1972, but was not reapplied in 1973. Weed control in glyphosate plots are, therefore, a result of weed control in the previous year plus the result of trifluralin applied for two years.

Plots were replicated four times in a randomized block design. Plot size was 10 by 30 ft with 30 inch row spacing. Visual ratings of percent johnsongrass control and soybean injury were made several times throughout the season. Soybeans were harvested from 20 ft of the center two rows of each plot on November 7, 1973.

Results

Adequate johnsongrass control was obtained in all treatments except for the control and the alachlor treatments (Table 1). According to visual ratings the best johnsongrass control, both early (June 26, 1973) and late (September 17, 1973) in the season, occurred in plots with the highest rate of trifluralin (2.5 lb/A which is three times the normally recommended rate). Trifluralin applied at two times the normally recommended rate (1.5 lb/A) also controlled johnsongrass satisfactorily (88% on August 17, 1973). Extra tillage in 1972 did not increase the effectiveness of trifluralin (1.5 lb/A) in 1973. The lowest rate of trifluralin (0.75 lb/A) controlled only 68% of the johnsongrass in its second consecutive year of application.

Plots which received an application of glyphosate postdirected in 1972 in addition to trifluralin (1972 and 1973) had satisfactory johnsongrass control (Table 1). Soybean injury caused by glyphosate did occur, however, in 1972. With 0.75 lb/A trifluralin, glyphosate treatment in 1972 increased johnsongrass control in 1973 with respect to the treatment with only 0.75 lb/A trifluralin. This difference was, however, not significant. At 1.5 lb/A trifluralin, no effect of glyphosate was noted in 1973.

A comparison of trifluralin and benefin for johnsongrass control during the first season of application was also made in this experiment (Table 1). Benefin is considered generally less active than trifluralin on a pound for pound basis. Laboratory results using the triphenyl tetrazolium assay developed in this laboratory indicated, however, that benefin was more

active than trifluralin on johnsongrass rhizomes. These field results indicate that on a weight basis, benefin is equal to trifluralin in controlling johnsongrass. This partially confirms the laboratory results using the triphenyl tetrazolium assay and indicates that benefin is more toxic to johnsongrass rhizomes than had been expected. This might be useful in areas where the residual problem of trifluralin at high rates makes this chemical undesirable.

Summary

Control of rhizomatous johnsongrass in field studies was satisfactory with the addition of 2 times the normally recommended rate of trifluralin. Glyphosate postdirected in the previous year increased johnsongrass control in plots receiving a normally recommended rate of trifluralin but did not increase control in plots which received two times the normally recommended rate. Benefin (3 lb/A) controlled johnsongrass as well as trifluralin (3 lb/A) in the first year of application.

Table 1. Control of Johnsongrass in Soybeans with Trifluralin and Glyphosate[a]

Herbicide 1972	Herbicide 1973	Rate of Herbicide Application (lb/A) 1972	Rate of Herbicide Application (lb/A) 1973	Johnsongrass Control 6/26/73 (%)	Johnsongrass Control 9/17/73 (%)	Soybean Yields (Bu/A)
Control	Control	---	---	0 d	15 b	25 b
Trifluralin	Trifluralin	½	.75	50 b	68 a	35 ab
Trifluralin	Trifluralin	1	1.5	78 ab	88 a	62 a
Trifluralin + extra tillage	Trifluralin	1	1.5	75 ab	78 a	51 ab
Trifluralin	Trifluralin	1.5	2.25	83 a	93 a	57 ab
Glyphosate + trifluralin	Trifluralin	½+½	.75	65 ab	73 a	49 ab
Glyphosate + trifluralin	Trifluralin	1+½	.75	68 ab	70 a	52 ab
Glyphosate + trifluralin	Trifluralin	½+1	1.5	78 ab	83 a	64 a
Glyphosate + trifluralin	Trifluralin	1+1	1.5	68 ab	83 a	64 a
Control	Trifluralin	---	3	58 ab	63 a	45 ab
Control	Benefin	---	3	58 ab	68 a	46 ab
Alachlor	Alachlor	4	4	30 c	18 b	23 b

[a]Values not followed by the same letter in the same column are significantly different at the 5% level according to the Student-Newman-Keul's test.

A Comparison of Sunflower Varieties Under Different Managements for Silage

N. A. Clark
Department of Agronomy

Purpose and Objectives

Corn silage is the leading producer of energy for dairy cattle on a single crop basis, but it is possible that certain multiple cropping sequences might outproduce corn in Maryland. In such a multiple crop sequence, a logical choice for the winter crop would be a cereal harvested as silage or a short season barley harvested as grain. The summer crop should be fast-maturing, highly productive, and drought tolerant. Drought tolerance is especially important because the winter crop leaves the soil low in moisture for the succeeding crop and, if summer rainfall is sparse, most crops will suffer. Sunflowers are drought tolerant and produce substantial tonnage in a short period of time.

The objectives of this study were to determine the potential yield and feeding value of sunflower silage under Maryland conditions. In order to do this, it was necessary to establish seeding rates and fertility levels for the sunflower types available for this area.

Procedures

Experiment 1. The seeding was made on June 27, 1973 on a Chester silt loam at the Forage Research Farm, Ellicott City, Maryland. A soil test conducted prior to establishing the experiment indicated that the P and K levels were in the medium range. The study was set up in a factorial arrangement consisting of two fertilizer levels (50-100-100 and 100-200-200), three plant populations (34,848, 69,696, and 139,392 plants per acre), and four sunflower varieties (Greystripe, Krasnodarets, Mingren, and Sundak) in a split-split plot design. Fertilizer levels were the whole plots, plant populations the first split, and varieties the final split. There were three replications.

Harvest was timed so that each variety would be removed just after the flowering stage. Krasnodarets and Mingren were harvested on September 5, 1973 when the total plant dry matter was approximately 17 percent. Sundak was harvested on September 8, also at 17 percent dry matter. Greystripe was harvested on September 19 with dry matter of approximately 19 percent.

Experiment 2. The seeding was established on June 20, 1973 on a Chester silt loam at the Forage Research Farm, Ellicott City, Maryland. The experimental design was a split plot with two varieties as whole plots and four populations and spacing arrangements as the sub plots. The varieties were Greystripe and Mingren. Populations and spacings were as follows:

Population plants/acre	Spacings
140,000	15-inch rows, 3-inch seed spacing within row
70,000	30-inch rows, 4 seeds (hill drop) at 12-inch spacing within row
140,000	30-inch rows, 4 seeds (hill drop) at 6-inch spacing within row
70,000	30-inch rows, 3-inch seed spacing within row
140,000	30-inch rows, 1.5-inch seed spacing within row

There were three replications. Harvest of varieties was timed so that each would be removed just after the flowering stage. Harvest of Mingren was on September 3, 1973 when the total plant dry matter was approximately 16 percent. Harvest of Greystripe was on September 12 when the plant dry matter was approximately 20 percent.

Experiment 3. Two sunflower varieties, Greystripe and Mingren, were no-till planted in stubble on July 7, 1973, two weeks after barley harvest, using a four-row no-till corn planter. The experimental area was on a Manor loam at the Forage Research Farm, Ellicott City, Maryland. Seeds averaged four inches apart in 30-inch rows for a population of approximately 52,000 plants per acre. However, the stand was quite variable. Prior to planting, 5-20-20 fertilizer was broadcast at 100 pounds per acre. The plots were four rows wide by 30 feet long. The design was a randomized complete block with four replications. Harvests were made shortly after each variety reached the

flowering stage. Mingren was harvested on September 8, 1973 with a total plant dry matter of approximately 15.5 percent. Harvest of Greystripe was on October 1 when the total plant dry matter was approximately 19 percent.

Results

Experiment 1. Of the three variables studied in this experiment (fertility level, varieties, and populations), only varieties and populations showed statistically significant differences (Table 1). Even though the soil test showed the phosphorus and potassium level to be only in the medium range, there was no yield response when the fertilizer rate was doubled. The short, early-maturing Krasnodarets was the lowest yielding variety of the four tested and, except in one treatment, produced less than two tons dry matter per acre. Sundak responded to the high population, and over both fertility levels averaged almost 2.5 tons of dry matter per acre. Greystripe was a consistently high producer ranging between 2.5 and 3.2 tons per acre over all populations and both fertility levels. Mingren was the second highest producer. Only at the low population - high fertility was the Mingren production statistically lower than that of Greystripe.

Experiment 2. Greystripe consistently outyielded Mingren at both populations and all spacing arrangements (Table 2). The top yielding treatment was Greystripe seeded in 15-inch rows at a row spacing of three inches. With the exception of this treatment, neither populations nor seed spacings were significant in influencing yields.

Experiment 3. Dry matter yields across replications varied from 1.8 to 2.5 tons per acre with Mingren and from 2.6 to 3.8 tons per acre with Greystripe (Table 3). The average yields for the two varieties were 2.1 and 3.3 tons per acre, respectively. Although these differences were biologically significant, the plot variability across replications was such that no statistically significant difference could be shown. The coefficient of variation obtained from these data was 46.5 percent. Stand variability was attributed

to the planter used in this study which, even though equipped with sunflower seed plates, dropped seed in an erratic pattern and resulted in nonuniform plant stands.

Summary

Three experiments were conducted at the Forage Research Farm, Ellicott City, Maryland, to determine, when the crop was to be harvested as silage, suitable sunflower varieties, plant populations, fertilizer levels, and seed spacing arrangements. In Experiment 1, where fertilizer levels were a variable, there was no yield response when the fertilizer rate was doubled. The variety Greystripe was consistently the highest yielder over all experiments. High plant populations generally produced greater dry matter tonnage, but in most cases not enough to justify higher seed costs. In Experiment 2, yields were not affected by various seed spacing arrangements with the exception of Greystripe which produced approximately a ton more dry matter per acre when seeded in 15-inch rows as compared with 30-inch rows.

Table 1. Sunflower dry matter silage yield for four varieties at two fertilizer rates and three plant populations. Experiment 1 - 1973.

Fertilizer Rates pounds/acre	Population plants/acre	Variety 1/ G	K	M	S
		DM tons/acre			
50-100-100 (L)	34,848 (L)	2.5 c 2/	1.7 a	2.3 c	1.9 b
	69,696 (M)	2.5 c	1.7 a	2.5 c	1.8 a
	139,392 (H)	3.0 c	1.6 a	2.3 c	2.3 c
100-200-200 (H)	34,848 (L)	3.1 c	1.5 a	2.1 b	2.1 b
	69,696 (M)	3.1 c	1.7 a	2.4 c	2.1 b
	139,392 (H)	3.2 c	2.0 b	2.4 c	2.5 c

1/ G = Greystripe M = Mingren
K = Krasnodarets S = Sundak

2/ Means followed by a different letter are significantly different at 5% level of probability.

Table 2. Sunflower dry matter silage yield for two varieties planted at two populations in five seed-spacing arrangements. Experiment 2 - 1973.

Spacing [1/]	Population	Varieties		
		Mingren	Greystripe	Average
		DM tons/acre		
A	140,000	2.8 a [2/]	4.6 c	3.7 A
B	70,000	2.5 a	3.2 b	2.8 B
C	140,000	2.8 a	3.2 b	3.0 B
D	70,000	2.7 a	3.7 b	3.2 B
E	140,000	2.7 a	3.7 b	3.2 B
Average		2.7 B	3.7 A	

1/ A = 15" rows, 3" seed spacing within row
B = 30" rows, 4 seeds (hill drop) at 12" spacing within row
C = 30" rows, 4 seeds (hill drop) at 6" spacing within row
D = 30" rows, 3" seed spacing within row
E = 30" rows, 1.5" seed spacing within row

2/ Means followed by a different letter are significantly different at 5% level of probability.

Table 3. Sunflower dry matter silage yield for two varieties no-till planted in barley stubble. Experiment 3 - 1973.

Variety	Replication I	II	III	IV	Average
	DM tons/acre				
Greystripe	3.4	2.6	3.2	3.8	3.3 n.s.
Mingren	2.3	2.5	1.8	1.9	2.1

Comparison of Propionic Acid and Ammonium Isobutyrate As Preservatives for High Moisture Hay

C. C. Sheaffer and N. A. Clark
Department of Agronomy

Purpose and Objectives

Hay is an important crop in Maryland, but large losses in quality and quantity occur due to exposure of the forage to inclement weather while drying and to the storage of hay at improper moisture levels. The application of propionic acid and ammonium isobutyrate, which possess fungicidal properties, to high moisture hay would minimize the risk involved in subjective determination of hay moisture. It would also allow for the production of high quality hay because of decreased leaf shattering which occurs at low moisture levels.

The objectives of this study were: (1) To evaluate the preserving ability of propionic acid and ammonium isobutyrate applied to aerobically stored forages, (2) To determine the chemical characteristics of forages treated with propionic acid and ammonium isobutyrate, and (3) To determine the most effective rates of propionic acid and ammonium isobutyrate for forage preservation.

Procedures

Propionic acid and ammonium isobutyrate were manually applied to alfalfa-timothy hay material using a CO_2 pressurized sprayer. The hay was stored in baled and chopped form with a moisture content ranging from 31 to 44 percent. The rates of application varied and are shown in Table 1.

After spraying, the chopped hay was stored in large burlap bags and hay for baling was forked into a stationary twine-tie baler. Thermocouples were inserted into the bales and bags, and temperatures were monitored throughout the storage period. After storage, the hay was analysed for *in vitro* digestibility, acid detergent fiber, acid detergent insoluble nitrogen, and Kjeldahl

nitrogen to determine the quality of the treated and untreated material.

Results

There was no significant difference between the preserving abilities of propionic acid and ammonium isobutyrate. However, there was a significant difference between the rates of application necessary to preserve the forage at a given moisture level. As the moisture content of the plant material increased, higher rates of propionic acid and ammonium isobutyrate were necessary for preservation.

Hay baled at 31 percent moisture content and sprayed with propionic acid and ammonium isobutyrate at rates of 1.50 to 2.00 percent had a lower acid detergent fiber content and a higher *in vitro* digestibility than hay which was untreated or that which was sprayed at the 1.00 percent rate (Table 2). There was no significant difference between the maximum temperatures of the hay to which propionic acid and ammonium isobutyrate were applied.

Hay chopped at 34 percent moisture and receiving the same treatments as the hay baled at 31 percent moisture had higher maximum temperatures and a higher acid detergent fiber content (Table 3). *In vitro* digestibility of the chopped hay was slightly higher due to the earlier time of cutting. There was no significant difference between the rates of application in reducing temperature and increasing *in vitro* digestibility. Hay sprayed with the 2.00 percent rate of application had a significantly lower acid detergent fiber content than that receiving the other treatments.

Hay baled with an average moisture content of 40 percent was preserved by propionic acid and ammonium isobutyrate application at the 3.00, 4.00, and 5.00 percent rates (Table 4). Hay treated at these rates had a significantly lower maximum temperature than the untreated hay or that treated at the 2.00 percent rate. Significantly lower acid detergent fiber and acid detergent insoluble nitrogen values at the 3.00, 4.00, and 5.00 percent rates

are reflected in a higher *in vitro* digestibility for those treatments.

Application of propionic acid and ammonium isobutyrate at the 3.00, 4.00, and 5.00 percent rates to chopped hay at 44 percent moisture was not as effective in maintaining forage quality (Table 5). The chopped hay had higher maximum temperatures, acid detergent fiber, and acid detergent insoluble nitrogen levels; *in vitro* digestibility was lower.

In three of the four experiments, hay to which ammonium isobutyrate was applied had a higher Kjeldahl nitrogen content than hay treated with propionic acid. As the rate of application increased, the Kjeldahl nitrogen content of the hay also increased (Table 6).

In the course of these experiments, it was found that propionic acid was considerably more corrosive than ammonium isobutyrate. It was also more hazardous to the operator than ammonium isobutyrate.

Summary

Application of propionic acid and ammonium isobutyrate to high moisture hay was effective in preserving the forage material and preventing mold growth. There was no difference in the preserving abilities of propionic acid and ammonium isobutyrate. Hay material sprayed with ammonium isobutyrate had a higher Kjeldahl nitrogen content. Ammonium isobutyrate was also safer to use due to the highly corrosive nature of propionic acid.

The moisture content of the forage material at the time of storage was the most important factor influencing the storage characteristics of the untreated hay and the effectiveness of a particular rate of application in preserving the hay. Hay stored at low moisture levels was preserved by low rates of organic acid and hay stored at high moisture levels required high rates of application for preservation.

Chopped hay stored at a similar moisture content as baled hay required increased rates of organic acid for effective preservation.

Table 1. Summary of hay experiments conducted during 1973 with baled and chopped alfalfa-timothy hay to which propionic acid and ammonium isobutyrate were applied at various rates.

Experiment Number	Form	Date	Cutting	Composition	Acid 1/	Rate 2/	% Moisture Range	% Moisture Mean
1	chopped	6-01-73	1st	75% timothy 25% alfalfa	Prop. AIB	0, 1.00, 1.50, 1.75, 2.00	25-42	34.0
2	baled	7-14-73	2nd	31% timothy 69% alfalfa	Prop. AIB	0, 2.00, 3.00, 4.00, 5.00	33-45	40.0
3	chopped	7-17-73	2nd	31% timothy 69% alfalfa	Prop. AIB	0, 2.00, 3.00, 4.00, 5.00	37-49	44.0
4	baled	8-27-73	3rd	10% timothy 85% alfalfa 5% weeds	Prop. AIB	0, 1.00, 1.50, 1.75, 2.00	24-43	31.3

1/ Propionic acid (Prop.), weight: 8.29 lbs/gal
Ammonium isobutyrate (AIB), weight: 8.61 lbs/gal

2/ Rates are expressed as a percentage of forage weight.

Table 2. Means for maximum temperature and chemical analyses of hay baled August 27, 1973 at 31 percent moisture and sprayed with propionic acid and ammonium isobutyrate at five rates.

Rate [1] %	Maximum Temperature °C	Chemical Analyses: In vitro Digestibility %	Chemical Analyses: Acid Detergent Fiber %	Chemical Analyses: Acid Detergent Insoluble Nitrogen %
0	49.3 a [2]	58.4 c	38.0 a	0.28 a
1.00	33.3 b	59.1 bc	37.7 ab	0.25 a
1.50	33.5 b	60.2 ab	35.4 b	0.24 a
1.75	33.2 b	60.9 a	35.4 b	0.24 a
2.00	31.6 b	60.7 ab	35.3 b	0.23 a

1/ Expressed for both preservatives on a weight basis.

2/ Means with the same letter are not significantly different at the 5% level of probability according to Duncan's Multiple Range Test.

Table 3. Means for maximum temperature and chemical analyses of hay chopped June 1, 1973 at 34 percent moisture and sprayed with propionic acid and ammonium isobutyrate at five rates.

Rate [1] %	Maximum Temperature °C	Chemical Analyses: In vitro Digestibility %	Chemical Analyses: Acid Detergent Fiber %	Chemical Analyses: Acid Detergent Insoluble Nitrogen %
0	48.7 a [2]	58.8 b	44.8 a	0.30 a
1.00	35.2 b	61.1 a	42.4 b	0.22 b
1.50	35.2 b	61.2 a	41.5 b	0.21 b
1.75	33.6 b	61.9 a	41.1 b	0.20 b
2.00	34.3 b	61.8 a	39.8 c	0.18 b

1/ Expressed for both preservatives on a weight basis.

2/ Means with the same letter are not significantly different at the 5% level of probability according to Duncan's Multiple Range Test.

Table 4. Means for maximum temperature and chemical analyses of hay baled July 14, 1973 at 40 percent moisture and sprayed with propionic acid and ammonium isobutyrate at five rates.

Rate 1/ %	Maximum Temperature °C	Chemical Analyses: In vitro Digestibility %	Acid Detergent Fiber %	Acid Detergent Insoluble Nitrogen %
0	58.1 a 2/	56.6 b	43.0 a	0.40 a
2.00	38.4 b	57.6 b	42.1 a	0.36 ab
3.00	34.1 c	59.6 a	37.3 b	0.30 bc
4.00	30.4 d	60.5 a	35.3 b	0.23 cd
5.00	30.3 d	60.2 a	34.5 b	0.21 d

1/ Expressed for both preservatives on a weight basis.

2/ Means with the same letter are not significantly different at the 5% level of probability according to Duncan's Multiple Range Test.

Table 5. Means for maximum temperature and chemical analyses of hay chopped July 17, 1973 at 44 percent moisture and sprayed with propionic acid and ammonium isobutyrate at five rates.

Rate 1/ %	Maximum Temperature °C	Chemical Analyses: In vitro Digestibility %	Acid Detergent Fiber %	Acid Detergent Insoluble Nitrogen %
0	59.6 a 2/	54.2 c	47.4 a	0.51 a
2.00	38.6 b	55.8 bc	47.1 a	0.45 ab
3.00	34.5 b	57.4 ab	41.7 b	0.33 bc
4.00	34.0 bc	59.1 a	39.2 b	0.28 c
5.00	33.2 c	59.1 a	37.9 b	0.27 c

1/ Expressed for both preservatives on a weight basis.

2/ Means with the same letter are not significantly different at the 5% level of probability according to Duncan's Multiple Range Test.

Table 6. Means for the Kjeldahl nitrogen content of hay sprayed with ammonium isobutyrate in three experiments.

Experiment Date	Rate of Application (%)				
	0	1.00	1.50	1.75	2.00
	%N				
6-01-73	1.44	1.57	1.63	1.67	1.72
	0	2.00	3.00	4.00	5.00
	%N				
7-14-73	2.42	2.42	2.45	2.60	2.64
7-17-73	2.35	2.50	2.59	2.75	2.79

Effects of Sewage Sludge on Soil plus the Yield and Chemical Composition of Corn and Soybeans

A. M. Decker, J. M. Walker, and R. L. Chaney
Department of Agronomy and U.S.D.A.

Purpose and Objectives

Increased environmental awareness by citizens and government is demanding that sewage sludge disposal be done by safe and beneficial procedures. As a result, much sludge may be recycled onto agricultural land. The amounts of sewage sludge which can be safely and profitably applied to agricultural lands are limited by the status of nitrogen, heavy metals, pathogens, and the crops to be grown on the land plus the intended use of these crops.

The objectives of this study were (1) To look at yields of corn and soybeans as affected by rates of sludge applied to field plots; (2) To determine heavy metal uptake of these crops; and (3) To look at changes in the soil brought about by these sludge applications.

Procedure

Digested sludge from Washington, D.C., was applied to a Sassafrass silt loam soil at rates of 0, 25, 50, and 100 dry tons per acre. Applications were made over a three day period: April 8-10, 1972. The sludge was applied in strips 140 feet long by 25 feet wide. Each long strip was divided in half with one end seeded to corn and the other to soybeans. Each half was further divided into three sections with half of each section fertilized with 400 lbs of a 0-20-20 fertilizer. The corn plots without sludge received, in addition, 160 lbs N/A broadcast prior to planting. The basic plot was, therefore, 12.5 by 23 feet. Because the sludge was applied in long strips without replication, only the interactions of sludge by fertility level could be tested statistically. Plant response data from the corn and soybean plots were treated as two separate experiments.

Corn silage, corn grain, and soybean yields per acre were determined.

Whole plant and seed samples were saved for chemical analyses. Corn silage was harvested from all plots within a given sludge rate and stored for a sheep feeding experiment to look at heavy metal accumulation within the animal tissue.

Results

Yields of corn and soybeans for 1973 are shown in Table 1. On plots without sludge, yields of both corn grain and silage were increased with fertilizer application; no statistical yield differences were found for soybeans as a result of fertilizer application. When sludge was applied, fertilizer did not increase the yields of either corn or soybeans.

Significant yield increases of both corn and soybeans occurred with sludge application; yields for both crops tended to level off at 50 tons of sludge per acre.

Yield responses for corn were similar to those obtained in 1972. However, soybean yields in 1972 were decreased at the high sludge rates; at least some of this yield reduction was the result of poor soybean stands in 1972. No establishment problems occurred in 1973, and yield increases resulted from sludge applications.

Amounts of nitrate in the soil were determined August 31, 1972 and May 30, 1973 (one year after sludge application). Accumulations occurred at all soil profile levels sampled. Greatest accumulation was in the top 12 inches and at the high sludge application rates (Table 2).

The application of sludge lowered the soil pH slightly and increased phosphorus levels rather markedly, but had little effect on magnesium or potash levels (Table 3).

The silage feeding study has not been completed and only a small number of the plant samples have been completely analyzed. Table 4 summarizes results from a few of the samples collected over the past two years. Zinc, copper, and cadmium levels in corn silage increased with increased sludge

application rates. Smaller increases also occurred with corn grain and the soybean seed.

Summary

1. Corn and soybean yields were markedly increased by the application of sludge.
2. Yield increases leveled off at 50 tons of sludge per acre.
3. Except at the zero sludge rate for corn, commercial fertilizer application had little effect on yield.
4. Sludge applications changed soil pH and nutrient status.
5. Based on data from two years, heavy metals were accumulated by the crop growing on sludge-treated soils.

Table 1. Yields of corn and soybeans grown on plots treated with four rates of digested sewage sludge and two fertilizer rates. 1973.

Treatment		Yields per Acre		
		Corn		
Sludge (T/A)	Fertilizer (lbs/A)	Silage (T/A)	Grain (bu/A)	Soybeans (bu/A)
0	0- 0- 0	6.10 f [1/]	33.6 d	36.5 b
	160-80-80	12.61 e	81.4 c	38.3 b
25	0- 0- 0	15.06 de	109.6 b	51.1 a
	0-80-80	17.38 cd	110.0 b	51.3 a
50	0- 0- 0	21.07 bc	163.9 a	57.1 a
	0-80-80	23.13 ab	165.6 a	54.1 a
100	0- 0- 0	26.05 a	172.8 a	55.5 a
	0-80-80	24.09 ab	168.5 a	54.0 a
C.V.%		11.3	11.0	6.0

1/ Data within a column followed by the same letter are from the same statistical population (5% level).

Table 2. Nitrate nitrogen in the soil profile as affected by sludge rates applied April 8 and 9, 1972.

Sludge Rates (T/A)	Soil Depth (in)	NO_3-N (ppm) 1972 1/	1973 2/ Soybeans	1973 2/ Corn	1973 3/ Corn
0	0-12	8.9	4.5	3.6	3.0
	12-24	5.4	3.0	2.0	2.3
	24-36	3.1	1.9	3.3	4.3
25	0-12	15.1	3.3	8.5	
	12-24	6.4	5.1	4.8	
	24-36	4.6	3.8	3.4	
50	0-12	62.1	25.3	14.6	
	12-24	17.9	13.9	8.4	
	24-36	7.4	8.3	7.5	
100	0-12	64.8	32.5	24.4	
	12-24	21.2	20.5	25.6	
	24-36	13.3	8.6	20.6	

1/ Soil samples taken August 31, 1972.

2/ Soil samples taken May 30, 1973.

3/ 160 lbs N per acre added as NH_4NO_3.

Table 3. Effect of sludge application on soil pH and magnesium, phosphorus, and potassium content of the soil.

Sludge Rate (T/A)	Soil Depth (in)	pH		Pounds per Acre					
				Mg		P_2O_5		K_2O	
		Corn	Soybeans	Corn	Soybeans	Corn	Soybeans	Corn	Soybeans
0	0-12	5.9	6.1	153	183	103	145	151	170
	12-24	5.4	5.5	125	155	15	17	58	74
	24-36	5.0	5.1	176	175	8	12	46	44
25	0-12	5.7	5.8	159	177	203	323	127	187
	12-24	5.4	5.3	155	146	18	35	60	78
	24-36	5.0	5.1	104	128	18	37	37	48
50	0-12	5.6	5.8	144	190	305	383	146	190
	12-24	5.1	5.2	182	167	18	33	61	84
	24-36	5.1	4.9	165	127	20	25	59	52
100	0-12	5.6	5.7	171	195	437	460	158	177
	12-24	5.5	5.2	200	197	32	27	74	78
	24-36	5.0	4.9	145	200	47	30	50	43

Table 4. Microelement contents of crops grown on soil to which sludge was added in spring of 1972.

Sludge Rates (T/A)	Crop Year	Zn	Cu	Cd	Cd/Zn (%)
		----- Mg/Kg dry weight -----			
		- - Corn Silage - -			
0	1972	20	7.5	0.5	2.5
	1973	30	8.2	0.2	0.7
25	1972	114	10.9	2.4	2.1
	1973	96	7.4	1.1	1.1
50	1972	148	9.4	3.7	2.5
	1973	134	7.0	2.0	1.5
100	1972	194	9.6	2.9	1.5
	1973	168	7.4	1.8	1.1
		- - Corn Grain - -			
0	1972	18.7	4.8	< 0.1	< 0.5
25	1972	33.2	4.5	0.3	0.9
50	1972	39.7	5.0	0.5	1.2
100	1972	41.2	4.4	0.3	0.7
		- - Soybeans - - (beans)			
0	1972	49	13.7	< 0.1	< 0.2
25	1972	86	15.2	0.2	0.2
50	1972	84	14.7	0.2	0.2
100	1972	83	14.0	0.2	0.2

Soil Temperature Responses of Corn Hybrids Developed for Either Warm or Cool Climates

A. M. Decker and J. M. Walker
Department of Agronomy and U.S.D.A.

Purpose and Objectives

It is widely recognized that temperature exerts a major influence on plant growth and crop yield, but the degree to which soil temperature *per se* controls these responses is not fully understood. The high relationship between air and soil temperatures contributes to this problem.

The majority of studies concerned with the effects of soil temperature on plant responses have been conducted either in a greenhouse or growth chamber where environmental parameters are controlled. While this has provided valuable information, such conditions are "artificial" and results are often difficult to translate to actual field situations.

In 1971, a single corn hybrid was grown in the field at four soil temperatures and three fertility levels; plant development and yield were markedly affected by both fertility and soil temperature. In 1972, three hybrids (early, medium, and late maturing) were grown at the same four soil temperatures at only one fertility; again temperature responses were marked.

The objectives of the present study were to look at soil temperature responses of three diverse genotypes with similar maturity dates which were produced from single crosses adapted to either warm or cool climates.

Procedure

Three Pioneer single cross corn hybrids (Cool,C1 x Cool,C3; Cool C1 x Warm,W2; and Warm,W1 x Warm,W2) were grown in the field at four soil temperatures (ambient, 16 C, 27 C, and 35 C). All plots were uniformly fertilized with 224, 99, and 372 kg/ha of N, P, and K, respectively. The soil pH was 6.3. Seeds of each hybrid were planted directly into the soil temperature plots June 1, 1973 (in previous studies, plants were started in the green-

house and transplanted into the field plots at the 2-to-3-leaf stage), and thinned to 77,511 plants/ha at the 3-leaf stage. Plots were covered with a uniform 5-cm straw mulch to maintain desired soil temperatures. Temperature plots were individually irrigated to maintain "uniform" soil moisture. Soil temperature and moisture levels were monitored throughout the growing season. Individual plant growth measurements were made weekly, developmental growth stages recorded, and dry matter yields of eight different plant components determined at harvest when plants were in the late dent stage.

Results

Plants emerged 4, 5, 6, and 12 days after seeding on 32 C, 27 C, ambient, and 16 C soil temperature plots, respectively. No differences were observed between hybrids at the three highest soil temperatures. At 16 C, the W1 x W2 hybrid was about one half day later than the other two hybrids.

Leaf development and plant height changes for three of the twelve weeks are given in Table 1. The first measurement was on June 8, 1973 and the last on August 27, 1973. There was a significant temperature response after only one week. Leaf development and plant height were most rapid at 35 C, followed by 27 C, ambient, and then 16 C. Plant growth rates were most rapid at high soil temperature; however, final plant height was generally lower at the warmer soil temperatures. This was generally true for all hybrids. On the other hand, final leaf numbers were highest at 35 C and least at 16 C. The relative growth rate, in terms of plant height and leaf development, of the three hybrids grown at the four soil temperatures shifted as the growing season progressed. The C1 x C3 hybrid, at maturity, was highest at each soil temperature, C1 x W2 was intermediate, and W1 x W2 was shortest. Leaf development, on the other hand, was generally lowest for C1 x W2; differences were smallest at the higher temperatures.

Dry matter yields per plant are given in Table 2. Tiller development did not show clear trends between the three hybrids. However, tillering

tended to increase with increased soil temperature as in previous years. No tillers appeared at 16 C soil temperature.

Average total dry matter yield was highest for C1 x C3 and least for W1 x W2. Trends were similar for each plant component except grain, where average grain yields were similar for all three hybrids. Dry matter yields of most plant components were least at 16 C, next at 35 C, with ambient and 27 C being similar. C1 x W2 produced the lowest grain yields at all but the 16 C soil temperature; at this temperature, W1 x W2 was lowest. C1 x C3 produced the highest grain yield at all soil temperatures. Grain yields varied from 12,704 kg/ha (202 bu/A) for C1 x C3 at ambient temperature, to 5,231 kg/ha (83 bu/A) for W1 x W2 at 16 C.

Summary

1. Soil temperature has a marked effect on the rate of plant development, the final dry matter production, and the various yield components.
2. Temperature responses were similar for the three hybrids tested. However, the magnitude of these responses was not the same for each hybrid, especially with regard to the various yield components.
3. Grain yields of hybrids adapted to warmer conditions (W1 x W2) were reduced by cold soil temperatures more than grain yields of cool-season hybrids (C1 x C3) grown at high soil temperatures.

Table 1. Leaf development and plant height of three single crosses grown at four field soil temperatures.

Soil Temp.	Hybrid 1/	Measurement Dates 6-19 Leaf Dev. (no.)	6-19 Height (cm)	7-16 Leaf Dev. (no.)	7-16 Height (cm)	8-20 Leaf Dev. (no.)	8-20 Height (cm)
Ambient	C1 x C3	6.22 e 2/	23.3 b	17.50 bc	206.5 a	19.91 b	310.8 a
	C1 x W2	5.67 f	21.2 b	16.81 cd	189.2 ab	18.05 d	282.5 bc
	W1 x W2	5.60 f	18.6 d	16.24 d	150.1 d	18.90 c	249.5 ef
	Average	5.83 T	21.0 S	16.85 S	181.9 R	18.95 S	280.9 R
16 C	C1 x C3	1.84 g	8.5 e	10.07 e	80.1 f	19.14 c	291.1 ab
	C1 x W2	1.95 g	8.5 e	10.19 e	81.9 f	17.34 e	277.1 bcd
	W1 x W2	1.95 g	8.2 e	9.41 e	57.6 f	17.76 de	232.8 fg
	Average	1.91 U	8.4 T	9.89 T	73.2 S	18.08 T	266.7 R
27 C	C1 x C3	6.85 cd	25.6 a	18.65 ab	217.5 a	20.00 b	309.4 a
	C1 x W2	6.40 e	23.2 b	17.16 cd	200.4 ab	18.43 d	276.9 bcd
	W1 x W2	6.54 de	21.6 b	17.23 cd	163.1 b-e	18.90 c	253.0 def
	Average	6.60 S	23.5 R	17.68 R	193.6 R	19.11 S	279.8 R
35 C	C1 x C3	8.35 a	26.8 a	19.58 a	206.1 ab	21.14 a	283.3 bc
	C1 x W2	7.07 c	20.4 c	17.90 bc	158.4 e	19.29 bc	258.1 cde
	W1 x W2	7.76 b	19.8 cd	17.37 cd	145.4 e	18.81 c	224.3 g
	Average	7.73 R	22.3 R	18.28 R	169.9 R	19.75 R	255.3 S
Average	C1 x C3	5.81 X	21.1 X	16.45 X	177.5 X	20.05 X	298.7 X
	C1 x W2	5.27 Y	18.3 Y	15.51 Y	157.5 Y	18.27 Z	273.6 Y
	W1 x W2	5.46 X	17.1 Z	15.06 Z	129.0 Z	18.59 Y	239.6 Z
C.V.%		2.6	4.6	1.9	8.1	1.2	2.2

1/ C1 x C3 = single cross from two inbreds adapted to cool conditions
C1 x W2 = single cross from one inbred adapted to cool and another to warm conditions
W1 x W2 = single cross from two inbreds adapted to warm conditions

2/ Numbers in each column followed by the same letter are from the same statistical population (5%); capital letters used for main effects.

Table 2. Dry matter yields per plant of three single crosses grown in the field at three soil temperatures.

Soil Temp.	Hybrid [1/]	Dry Matter Yield in grams per plant			
		Stalks	Leaves	Grain	Total
Ambient	C1 x C3	94.5 abc [2/]	72.7 ab	163.9 a	382.8 ab
	C1 x W2	100.5 ab	58.5 cd	119.3 abc	321.6 bcd
	W1 x W2	51.4 def	51.6 ef	134.8 ab	280.8 c-f
	Average	82.1 S	60.9 S	139.3 R	328.4 R
16 C	C1 x C3	65.2 de	54.0 c-f	93.4 bc	248.1 def
	C1 x W2	51.1 ef	43.7 fg	87.2 bc	207.8 fg
	W1 x W2	38.1 f	35.3 g	67.5 c	163.1 g
	Average	51.5 U	44.3 U	82.7 T	206.3 T
27 C	C1 x C3	114.7 a	78.9 a	145.6 ab	401.2 a
	C1 x W2	99.8 abc	62.8 bcd	113.3 abc	325.4 abc
	W1 x W2	59.6 def	52.7 def	128.8 abc	301.1 cde
	Average	91.4 R	64.8 R	129.2 R	342.6 R
32 C	C1 x C3	77.4 bcd	64.5 bc	111.3 abc	305.1 cd
	C1 x W2	73.3 cde	50.1 ef	94.0 bc	254.7 c-f
	W1 x W2	54.0 def	44.2 fg	101.0 abc	228.8 efg
	Average	68.2 T	52.9 T	102.1 S	262.9 S
Average	C1 x C3	88.0 X	67.5 X	128.6 X	334.3 X
	C1 x W2	81.2 X	53.8 Y	103.5 X	277.4 Y
	W1 x W2	50.8 Y	46.0 Z	108.0 X	243.5 Z
C.V.%		4.6	4.9	16.6	7.4

1/ C1 x C3 = single cross from two inbreds adapted to cool conditions
C1 x W2 = single cross from one inbred adapted to cool and another to warm conditions
W1 x W2 = single cross from two inbreds adapted to warm conditions

2/ Numbers in each column followed by the same letter are from the same statistical population (5%); capital letters used for main effects.

Ground Water Table Studies on the Bertie and Mattapex Soils

J.E. Foss and F.P. Miller
Department of Agronomy

Purpose and Objectives

The purpose of this investigation was to more accurately predict the time of year, length of interval, and depth that the water table is present in the Bertie and Mattapex soil profiles. Previous studies have shown that morphological data and drainage class are good indicators of the presence of water table in the soil profile for significant periods during the year. More quantitative data are required, however, on actual fluctuations of water tables over long periods of time to provide information on soil interpretation and on the genesis of mottling and gleying in soils.

Procedures

Four wells for studying ground-water fluctuations were installed at the Wye Institute (Queen Annes County) in 1968. The 10-foot wells were all cased with non-perforated, galvanized down-spouting. The lower two feet of each well has filled with sand which seeps into the open bottom of each pipe. For this reason, the water tables can only be measured to a depth of about 80 to 90 inches instead of ten feet. Measurements of water table depth were made approximately biweekly with a DR 760A water level indicator (Soiltest, Inc.)

The soils selected for study were the Bertie and Mattapex series. They are formed on silty Coastal Plain sediments underlain by sandy materials at a depth of 30 to 40 inches. The Bertie and Mattapex soils are somewhat poorly drained and moderately well drained, respectively. Rainfall data were obtained from the weather station located at the Wye Institute.

Results

Figure 1 shows the water table fluctuations for the Bertie and Mattapex soils from March 1968 to June 1973. Data from only two of the four wells are plotted in Figure 1. The rainfall, in 10-day intervals, for this period is given in the lower portion of the figure. As shown in past studies, drainage class and morphology are good indicators of the presence and persistence of water tables in soils. One of the most important findings of this study is the variability of water table movement during the six years of observations. In most cases, water tables are high in the spring of the year (March through May) and low during the summer. However, in the spring of 1969 water tables were not detected and in 1971 they were below 70 inches for these two soils. This resulted from limited or evenly distributed rainfall during the fall and early spring of these intervals.

A detailed look at water table fluctuations in the Bertie soil and monthly rainfall values from October through March is given in Figure 2. Total amount of rainfall during this 6-month interval appears to be an important factor in water table movement during this period, but distribution during this interval also seems to be a factor. For example, in 1968-69, when the water table was below 100 inches, the 14.31 inches of rainfall was rather evenly distributed from October through March. During 1967-68, however, the December and March rainfall totals were 5.33 and 4.35 inches, respectively and this resulted in a rapid rise in the water table during March.

During August of 1971, the total rainfall was 10.6 inches. This amount of rain was instrumental in partially recharging the soil with water, and then with an additional 8.04 inches of rainfall during October, the water table rose during the fall and winter. This pattern seems to deviate from the normal conditions. The water table during 1972-73 was noted near the surface in mid-December. This resulted from the 16.33 inches of rainfall recorded for October through December.

Summary

Investigations of water table movement in Bertie and Mattapex soils at the Wye Institute for the past six years have shown that soil drainage class is a good indicator for predicting the overall water table levels in a landscape unit. Long-term studies are needed, however, to really predict the average water table depth in these soils during the winter and spring. The most important factors contributing to water table fluctuations in a given soil are: (1) total rainfall during the fall, winter, and spring, and (2) the monthly distribution of rain during periods of low evapotranspiration.

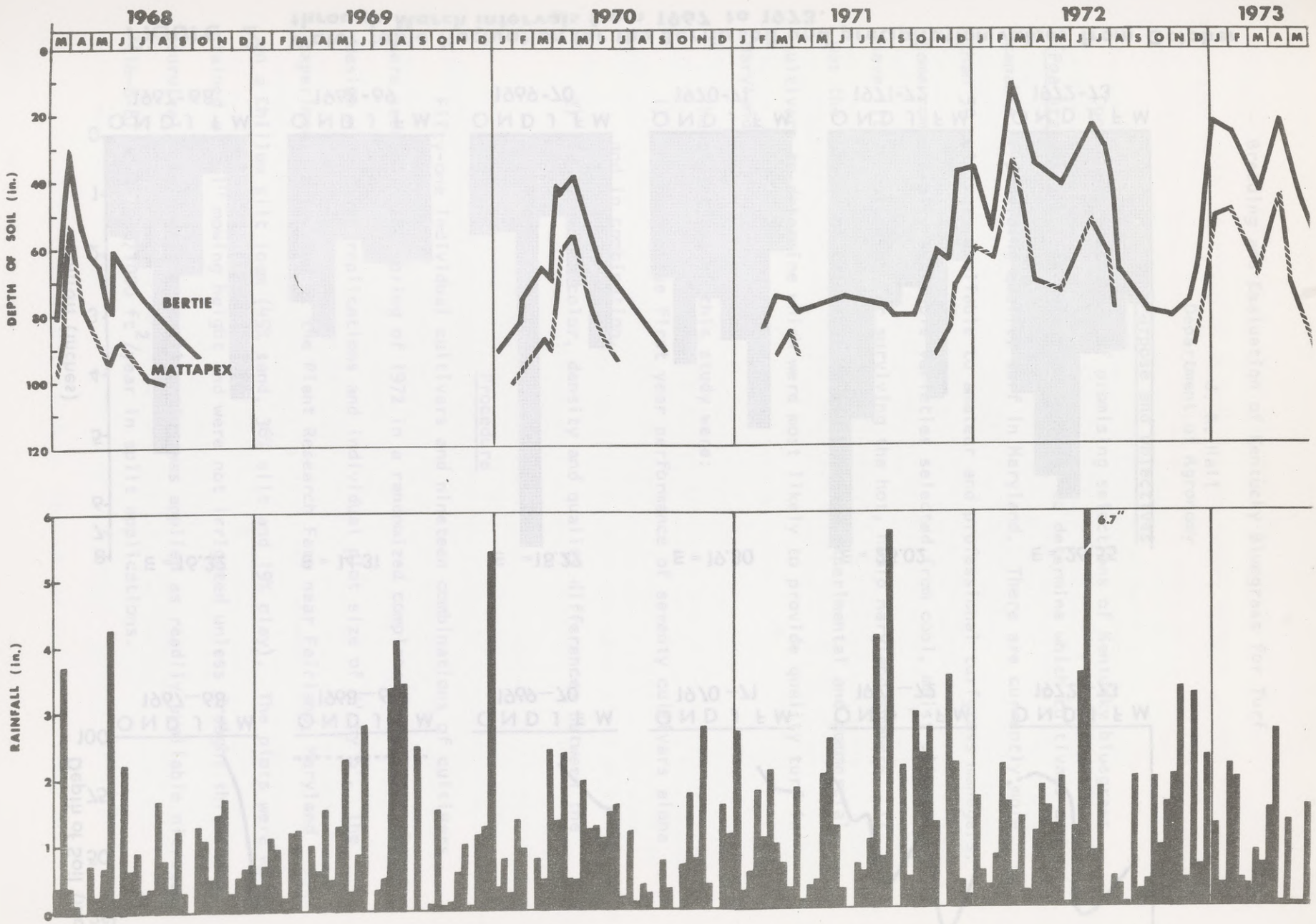

Figure 1. Ground water levels of the Bertie and Mattapex soils and precipitation at the Wye Institute from March 1968 to June 1973.

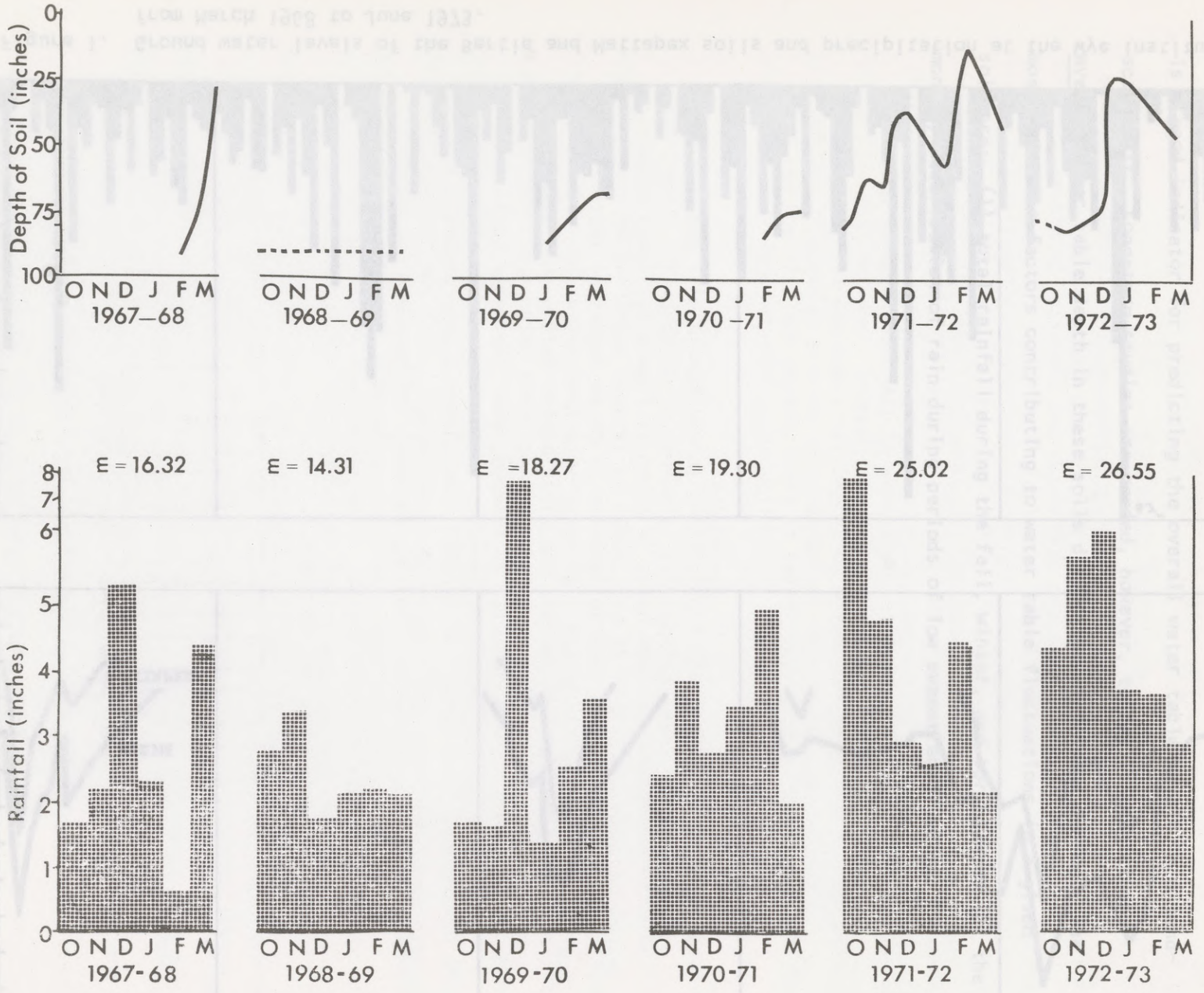

Figure 2 **Water table fluctuation for the Bertie soil and precipitation values from October through March intervals from 1967 to 1973.**

Breeding and Evaluation of Kentucky Bluegrass for Turf

J. R. Hall
Department of Agronomy

Purpose and Objectives

Continuous evaluation of promising selections of Kentucky bluegrass (*Poa pratensis* L.) is essential in order to determine which cultivars are capable of providing quality turf in Maryland. There are currently more than 50 cultivars available to amateur and professional turfgrass managers. Some commercially available varieties selected from cool, moist climates have little potential for surviving the hot, humid Maryland summers. It was the purpose of this test to evaluate new experimental and commercial cultivars to determine which were most likely to provide quality turf in Maryland.

The objectives of this study were:

1) To compare the first year performance of seventy cultivars alone and in combination.
2) To determine color, density and quality differences between the cultivars.

Procedure

Fifty-one individual cultivars and nineteen combinations of cultivars were seeded in the spring of 1972 in a randomized complete block experimental design with three replications and individual plot size of 4' by 6'. The experiment is located at the Plant Research Farm near Fairland, Maryland on a Chillum silt loam (45% sand, 36% silt and 19% clay). The plots were maintained at a 1" mowing height and were not irrigated unless drought threatened survival. Maintenance fertilization was applied as readily available nitrogen (16-8-8) at 3 lb N/1000 ft^2/year in split applications.

From April 1973 to November 1973 monthly color, density and quality ratings were taken. Disease damage was recorded as it occurred. All ratings were made on a 1-9 scale with 9 equal to a maximum value. A rating of 6 or greater was considered to be acceptable. Quality ratings reflect the ability of each cultivar or blend of cultivars to maintain a dense, firm, smooth, pest-free turfgrass surface. The six basic components of turfgrass quality: Uniformity, density, texture, growth habit, smoothness and color are considered in making the quality ratings. The relative importance of these components varies with the purpose for which the turf is to be utilized. In this instance where the cultivars are being evaluated at a 1" mowing height for possible use on golf course fairways, smoothness and density are of utmost importance.

Results

Nineteen of the fifty one cultivars tested maintained seasonal quality ratings of 6.0 or greater (Table 1). Monopoly, P-59, Adelphi, Parade, BA 61-24 and BA 62-59, P-57 and P-59, PSU-190 and Warrens A-34 were the only cultivars with an acceptable quality (greater than 6.0) rating every month from April to November. Seasonal averages are mislaeading for many varieties as high scores in one or two months have masked the fact that the variety was less than acceptable during two or three months of the testing period. Nugget, Campina, EVB 305, and NK-200 appear to be totally unsuited to the Maryland climate. Merion, Pennstar and Sodco exhibited their usual tendency of slow establishment. Merion quality was severely hampered in the spring of 1973 by a severe infestation of stripe smut. Kenblue greened up early but was severely attacked by Helminthosporium spp. in May, June and July. Baron showed good seedling vigor and developed strongly as the season

progressed. Victa, Windsor and Vantage performed well alone and in combination. Vantage exhibited less than desirable resistance to Helminthosporium spp. and rust, however, it recovered quickly. Sydsport continued to exhibit susceptibility to Dollar Spot disease and its seasonal quality average was severely decreased by the Dollar spot damage incurred in September. Bonnieblue and Majestic also faltered under drought conditions and Dollar spot invasion associated with the September ratings. Warrens A-34, Parade and Monopoly were extremely strong varieties under the conditions of this trial. The extremely dark color of Adelphi was especially noticeable in the spring and fall months. Mixtures of Merion and Kenblue, Merion and Pennstar, and Victa and Vantage provided better quality than any of the cultivars did alone. The improvement in quality brought about by blending was not evident in all cases. A mixture of Merion and Baron produced lower quality than Baron alone. The addition of red fescues and perennial ryegrasses to Kentucky bluegrasses did not improve turfgrass quality. Ryegrass-Bluegrass combinations were especially diasppointing.

Summary

The data indicate that only 13 percent of the entries tested were capable of providing acceptable turfgrass quality from April through November under environmental and edaphic conditions existing in Maryland. This information is vital in establishing turfgrass recommendations for the State of Maryland. Varieties are evaluated for a minimum of 3 years before they are recommended by the University of Maryland. Final recommendations are made based upon experimental and field performance of the varieties.

Acknowledgements

The author wishes to express his appreciation for the computer time made available through the facilities of the Computer Science Center of the University of Maryland and to Andrew J. Teutsch and Thomas J. Lavery for their technical assistance.

Table 1. 1973 Quality ratings for fifty-one single cultivars and nineteen combinations of cultivars tested at the Plant Research Farm near Fairland, Maryland.

Cultivar	Quality Rating								Average Qualtiy Rating
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
Nuggett	5.00	4.33	6.33	7.00	4.00	1.00	1.66	3.33	4.08
Merion	5.00	5.33	5.33	5.66	5.66	5.33	5.66	6.33	5.42
Fylking	5.66	5.66	7.00	7.33	5.66	5.66	6.00	6.33	6.16
Glade	5.66	5.66	6.33	6.33	5.33	4.33	5.33	5.66	5.57
P-142	5.66	5.33	6.33	6.00	4.66	3.66	4.00	5.33	5.12
Kenblue	6.33	4.00	4.00	4.66	5.00	5.66	6.66	6.00	5.28
Baron	5.66	6.00	6.33	6.33	6.66	5.66	6.66	7.00	6.28
Victa	6.33	6.00	6.66	6.66	6 00	5.33	5.66	6.66	6.16
BA 61-91	5.66	5.66	6.66	6.66	5.66	5.66	7.00	6.66	6.20
BA 62-55	5.66	5.66	6.33	6.33	5.66	4.33	5.66	5.66	5.64
Vantage	5.33	5.00	5.00	5.33	6.66	7.00	6.33	7.00	5.95
Park	6.33	5.33	5.00	5.66	5.66	5.66	6.00	6.66	5.79
Windsor	5.33	5.66	6.66	6.33	6.66	7.33	7.66	7.00	6.57
Sydsport	5.66	6.66	7.33	7.33	5.66	3.66	5.00	5.33	5.82
Bonnieblue	6.00	6.00	7.00	7.33	6.33	4.33	5.00	5.66	5.96
Majestic	5.33	5.66	6.00	6.33	6.00	4.33	5.66	6.00	5.66
Campina	5.33	5.00	5.33	5.00	4.00	3.00	3.00	4.33	4.37
Monopoly	6.66	6.66	6.66	6.66	6.66	7.00	6.66	6.66	6.70
Galaxy	4.66	4.66	6.00	5.66	5.00	5.33	6.00	5.66	5.37
Geronimo	5.66	5.00	6.00	5.66	5.66	5.00	6.00	6.33	5.66
P-57	5.33	5.00	6.00	6.33	6.66	7.00	8.00	7.00	5.74
Kl-131	6.00	6.00	6.00	6.33	5.33	5.33	5.33	5.66	5.74
Kl-132	6.00	6.00	6.66	6.33	6.00	5.00	5.33	6.00	5.91
Kl-133	6.00	6.00	6.33	7.00	5.66	5.00	5.00	6.33	5.91
Kl-138	6.33	5.66	6.00	6.33	4.66	3.66	4.66	5.66	5.37
Kl-143	6.33	6.33	7.00	7.00	5.66	4.66	5.33	5.66	6.00
Kl-155	6.33	6.33	7.00	7.33	6.33	5.66	7.00	6.33	6.54
Kl-157	6.00	5.00	5.66	6.66	6.66	6.33	6.66	7.00	6.25
Kl-158	5.66	4.33	4.33	5.00	6.66	6.66	7.33	7.33	5.91
Kl-187	6.33	6.00	6.33	6.00	5.66	5.33	5.33	6.00	5.87
P-59	7.00	6.66	6.66	7.00	6.33	6.00	6.66	7.00	6.66
Sodco	5.00	5.00	5.00	5.66	5.66	6.00	6.00	5.66	5.62
MLM 18001	5.00	5.66	6.00	6.66	5.33	5.00	5.33	5.33	5.54
Adelphi	6.33	6.00	6.33	7.00	6.33	6.66	6.00	6.33	6.37
Parade	7.33	7.00	7.33	7.33	7.33	7.00	7.00	7.00	7.12
EVB 282	5.33	5.00	6.33	6.00	6.00	6.33	7.00	7 00	6.12
EVB 305	5.33	6.00	6.33	6.33	4.66	2.33	2.66	4.00	4.70
EVB 305	5.33	6.00	6.33	7.00	4.66	2.33	3.00	5.00	5.24
EVB 391	6.33	6.66	6.33	7.33	6.66	5.00	6.00	6.66	5.54
Pennstar	5.00	5.33	6.00	6.00	5.66	5.00	5.33	6.00	5.54
Merion + Kenblue	6.33	5.33	5.00	6.66	6.00	5.33	6.33	6.66	5.83
Merion + Pennstar	5.66	6.00	6.00	6.66	6.00	5.00	5.00	6.00	5.79
Merion + Baron	6.00	5.33	6.33	7.00	5.66	5.00	5.33	5.66	5.79
Nuggett + Pennstar	5.33	6.00	7.00	7.33	5.00	3.00	3.66	4.66	5.25
Nuggett + Glade	6.00	6.00	7.00	7.33	5.33	4.00	4.00	5.66	5.66
Nuggett + Park	5.66	5.33	5.66	6.33	6.00	5.33	6.00	6.00	5.79
Vantage + Victa	6.00	6.00	6.33	7.00	7.33	7.00	7.00	7.00	6.70
P-57 + P-59	6.66	6.66	6.33	7.00	7.00	7.33	7.33	7.33	6.45

Table 1 (con't)

Cultivar	Quality Rating								Average Quality Rating
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
Fylking+Jamestown[a]	4.66	5.00	5.33	5.66	4.33	4.33	5.00	5.33	4.95
Fylking+C-26	5.00	6.33	6.66	7.00	5.33	4.33	5.00	5.66	5.75
Fylking+Pennlawn[a]	5.33	5.33	5.33	5.66	5.33	4.00	4.66	6.33	5.33
Fylking+Pennfine[b]	5.33	4.66	4.66	4.66	5.00	5.66	5.66	6.00	5.20
Delft	5.33	6.66	5.66	6.00	5.33	3.33	4.00	5.00	5.25
PSU-190	6.00	6.33	6.66	6.66	6.33	6.66	6.66	6.66	6.45
PSU-150	4.66	5.66	5.66	6.33	5.66	6.00	6.33	5.66	5.78
RAM #2	6.33	6.33	6.66	7.00	5.66	4.00	5.00	6.00	6.00
P-133	5.66	6.33	6.00	7.33	6.66	6.00	6.00	6.66	6.33
PSU-197	6.33	6.33	6.00	6.33	5.66	5.66	6.00	6.00	6.08
P-141	5.66	5.00	6.33	6.66	5.66	7.00	7.00	7.33	6.33
P-151	6.00	5.66	5.33	5.66	6.00	5.00	6.00	6.00	5.83
PSU-169	4.66	4.66	5.00	5.00	5.00	5.00	5.33	6.00	5.12
Adelphi+Nuggett	4.66	5.00	6.66	6.66	6.00	5.00	6.00	6.00	5.87
Blend 38	6.00	6.33	6.66	6.33	6.00	5.33	6.33	6.00	6.25
40-40-20[c]	5.33	5.33	5.66	6.00	6.00	4.66	5.33	5.66	5.58
30-30-30-10[c]	6.00	5.00	6.00	6.33	5.66	5.00	5.33	6.00	5.71
NK-200[b]	4.66	5.33	4.00	3.33	3.33	2.33	4.66	4.66	4.33
95%Merion+5%NK-200[b]	5.00	5.00	5.33	5.33	5.33	5.00	5.33	6.33	5.37
90%Merion+10%NK-200[b]	5.33	5.66	5.33	4.33	5.33	4.66	5.00	6.00	5.25
80%Merion+20%NK-200[b]	4.00	5.00	5.00	4.33	3.66	3.66	4.33	5.33	4.50
Warrens A-34	6.00	6.66	7.00	7.33	7.66	7.33	7.33	7.66	7.12
5% Bayes LSD	1.53	1.69	0.90	1.15	1.05	1.26	1.16	1.20	
Ave.	5.69	5.66	6.04	6.28	5.71	5.09	5.63	6.05	

[a]Jamestown, Pennlawn and C-26 are red fescue cultivars

[b]Pennfine and NK-200 are perennial ryegrass cultivars.

[c]40-40-20 is 40% Merion, 40% South Dakota Certified and 20% Pennlawn creeping red fescue. 30-30-30-10 is 30% Merion, 30% South Dakota Certified, 30% Fylking and 10% Pennlawn creeping red fescue.

Effect of Postemergence Nonselective Herbicides And Fertilization upon *Poa annua* Populations in Kentucky Bluegrass (*Poa pratensis* L.) Sod

J. R. Hall
Department of Agronomy

Purpose and Objectives

This study was designed to evaluate low rates of postemergence herbicides and summer fertilization for their effectiveness in removing *Poa annua* from eight month old Kentucky bluegrass (*Poa pratensis* L. "Warrens A-34") sod. The objective of the study was to evaluate bromacil (5-Bromo-3-sec-Butyl-6-methyluracil), terbacil (3-tert-butyl-5-chloro-6-methyl uracil), Pronamide (3,5-dichloro-N-(1,1-dimethyl-2-propynyl)benzamide) and Paraquat (1,1-dimethyl-4,4'-bipyridinium chloride ion) at various rates to determine their ability to remove *Poa annua* from Kentucky bluegrass sod. The effect of summer fertilization upon *Poa annua* eradication was determined over the herbicide treatments.

Procedure

The experiment was conducted at the Princeton Turf Farm near Centreville, Maryland on a Elkton silt loam soil (14% sand, 68% silt and 18% clay) with a pH of 6.7 and medium levels of extractable phosphrus and potassium. The turfgrass was seeded in September of 1971 to Warrens A-34 Kentucky bluegrass. Fertilization program included 500 lb of 10-20-20 per acre plowed down in September, 1971 and a top dressing of 300 lb 10-6-4 in late Oct. 1971. In the spring of 1972 the seeding area was approximately 20% covered with *Poa annua*. In July 1972 the mowing height was raised to 5 inches. On June 6, 1972 the treatments listed in Table 1 were applied in water with an Amchem metermiser, gravity flow centrifugal sprayer at the rate of 43 gallons per acre. Air temperature was 75°F and the soil was moist. The experimental design was a split plot with three replications. The main plot treatments were herbicide types and rates and the sub-plot treatments were fertilization

or no fertilization. The plot size of the basic experimental unit was 3 feet by 15 feet. On June 12, 1972 half of each main plot was fertilized with 1 lb N/1000 sq. ft. as 16-8-8. This fertilizer application was repeated in July, August and September of 1972 and in February of 1973. The plots were evaluated for color and kill on June 12, 1972 (Table 1), quality and percent of plot infested with living Poa annua June 28, 1972 (Table 2) and density, quality and percent of plot infested with living Poa annua on March 13, 1973 (Table 3). Trade names of materials used are: bromacil (Hyvar-X), terbacil (Sinbar), pronamide (Kerb), and paraquat (Paraquat cl).

Results

The quickest kill of the turfgrass was provided by paraquat (Table 1). Color ratings were significantly lower for all rates of paraquat, the high rate of bromacil and the intermediate rate of terbacil.

Twenty two days after herbicide application only the check plot plus fertilization had acceptable turfgrass quality (Table 2). All treatments were effectively decreasing shoot growth and causing discoloration of the turf.

Twenty two days after herbicide application pronamide still was not affecting the Poa annua (Table 2). Good kill of the existing Poa annua was achieved with all rates of bromacil, terbacil and paraquat. The encroachment of Poa annua was decreased by the application of fertilizer in June (Table 2). This was likely due to the fertilizer increasing the competitiveness of the Kentucky bluegrass.

It was hypothesized that the herbicide materials applied at low rates would effectively kill the Poa annua and the shoots of the Kentucky bluegrass, leaving the rhizomes of the Kentucky bluegrass for regeneration of sod. The ineffectiveness of pronamide in summer heat and the lack of soil residual with paraquat allowed Poa annua to continue germinating in these plots, and

in fact by March 13, 1973 the percentages of Poa annua in the unfertilized Paraquat and pronamide plots was highest (Table 3). Bromacil and terbacil at 3 oz. rates did stop Poa annua germination for at least 4 weeks but the decrease in vigor of the Kentucky bluegrass caused by these rates allowed the Poa annua to invade during the winter. Summer fertilization did reduce the amount of Poa annua in all plots. Fertilization alone did not significantly reduce the population in the check plot (Table 3). In this instance where nitrogen levels were adequate during the establishment phase, there was no reduction in Poa annua brought about by summer fertilization where the Kentucky bluegrass vigor was not decreased by herbicide treatment. Where the vigor of the Kentucky bluegrass was decreased by the herbicide treatment fertilization did increase the density and quality of the Kentucky bluegrass and reduce the percentage of Poa annua in the plot (Table 3).

Summary

The use of low rates of bromacil, terbacil, pronamide and paraquat are not recommended for removal of Poa annua from Kentucky bluegrass. In situations where young sod is infested with Poa annua the best management approach to suppress Poa annua is a good sound turfgrass fertilization program coupled with a high mowing height which will provide the Kentucky bluegrass with maximum competitive vigor.

Acknowledgements

The author wishes to thank: Princeton Turf Farm, Centreville, Maryland, for allowing this experiment to be conducted on their land and for maintaining the turf for the duration of the experiment; and Andrew J. Teutsch for his technical assistance. The computer time for this project was supported in full through the facilities of the Computer Science Center of the University of Maryland.

Table 1. Effect of treatments applied June 6, 1972, upon color and kill of established Kentucky bluegrass rated on June 12, 1972.

Material	Rate (Active Ingredient/A)	Rating	
		Color	Kill[b]
Bromacil	1 oz.	5.7	3.3.
	2 oz.	5.3	3.3
	3 oz.	4.3	4.0
Terbacil	1 oz.	5.0	3.3
	2 oz.	4.3	4.0
	3 oz.	4.7	2.3
Pronamide	1 oz.	5.3	2.7
	2 oz.	5.7	3.0
	3 oz.	5.7	2.0
Paraquat	1 oz.	2.3	6.3
	2 oz.	2.0	7.3
	3 oz.	1.3	7.7
Check	0 oz.	5.6	1.7
Bayes LSD 5%		1.1	2.1

[a]Color ratings were made on a 0 to 9 scale where 9=maximum dark green color, 6=green of Kenblue Kentucky bluegrass 0=bleached tan straw color.

[b]Kill ratings were made on a 0 to 9 scale and express injury to the existing Kentucky bluegrass where 9=total shoot kill, 6=moderate shoot kill and 0=no injury to Kentucky bluegrass shoots.

Table 2. Effect of treatments applied June 6, 1972, upon turfgrass quality and percent of plot infested with living Poa annua rated on June 28, 1972.

Material	Rate (Active Ingredient/A)	Rating: Quality[a] Fertilized	Rating: Quality[a] Not Fertilized	Rating: % Poa annua[b] Fertilized	Rating: % Poa annua[b] Not Fertilized
Bromacil	1 oz.	4.7	3.7	7	5
	2 oz.	3.3	3.3	3	0
	3 oz.	3.3	2.3	0	0
Terbacil	1 oz.	5.0	3.7	7	5
	2 oz.	4.0	3.3	0	5
	3 oz.	4.0	2.7	2	0
Pronamide	1 oz.	5.0	4.0	30	35
	2 oz.	4.7	3.3	43	33
	3 oz.	4.7	4.0	32	38
Paraquat	1 oz.	4.7	3.3	8	3
	2 oz.	3.7	3.0	2	3
	3 oz.	2.3	1.7	2	3
Check	0 oz.	6.0	4.3	18	27
Bayes LSD 5%		Not applicable[c]		14	14

[a]Quality rating were made on a 0 to 9 scale when 0=maximum turfgrass quality, 6=acceptable quality and 0=bare ground. Factors considered in the quality rating are uniformity, density, texture, surface smoothness and color.

[b]%Poa annua is visual estimate of the percent of the plot area covered by Poa annua.

[c]Bayes LSD cannot be calculated when F value less than 1.0.

Table 3. Effect of treatments applied June 6, 1972, upon turfgrass density, quality and percent of plot area infested with Poa annua rated on March 13, 1973.

Material	Rate (Active Ingredient/A)	Rating: Density[a] Fertilized	Density[a] Not Fertilized	Quality[b] Fertilized	Quality[b] Not Fertilized	% Poa annua[c] Fertilized	% Poa annua[c] Not Fertilized
Bromacil	1 oz.	6.0	5.0	5.7	5.0	5	7
	2 oz.	5.3	4.3	5.3	4.3	5.	13
	3 oz.	4.7	4.0	4.7	3.3	22	35
Terbacil	1 oz.	6.0	5.0	6.3	4.7	2	8
	2 oz.	5.7	4.3	5.0	4.3	10	23
	3 oz.	4.7	4.7	5.0	4.3	17	22
Pronamide	1 oz.	5.0	5.0	5.0	4.6	2	13
	2 oz.	3.7	3.3	3.3	3.0	43	48
	3 oz.	3.3	3.3	2.7	2.3	35	47
Paraquat	1 oz.	5.3	4.3	5.3	4.3	7	20
	2 oz.	5.7	5.0	5.7	4.3	8	27
	3 oz.	4.0	3.3	4.0	3.0	22	40
Check	0 oz.	6.3	5.7	5.7	5.0	0	3
Bayes LSD 5%		1.1	1.1	1.3	1.3	Not applicable[d]	

[a]Density ratings were made on a 0 to 9 scale where 9=maximum turfgrass density, 6=acceptable turfgrass density and 0=bare soil.

[b]Quality ratings were made on a 0 to 9 scale where 9=maximum turfgrass quality, 6=acceptable quality and 0=bare ground. Factors considered in the quality rating are uniformity, density, texture, surface smoothness and color.

[c]% Poa annua is visual estimate of the percent of the plot area covered by Poa annua.

[d]Bayes LSD cannot be calculated when F value less than 1.0.

Effect of Repeated Preemergence Herbicides Upon Smooth Crabgrass Control, Turfgrass Quality and Root Activity

J. R. Hall, E. E. Deal and A. J. Powell
Department of Agronomy

Purpose and Objectives

Conditions of intensive turfgrass management often necessitate repeated application of preemergence herbicides. This study was designed to determine the effect of repeated preemergence herbicide applications upon smooth crabgrass (Digitaria ischaemum (Schreb.)Muhl.) germination, turfgrass quality and root activity.

Procedures

This experiment was conducted on a Kentucky bluegrass-creeping red fescue turf at the University of Maryland Plant Research Farm, Fairland, Maryland. The turf was maintained at 1-inch height of cut. The soil was a Chillum silt loam (45% sand, 36% silt and 19% clay). Soil pH was 6.0, phosphorus (P_2O_5) availability 201 lb/Acre, extractable potassium (K_2O) 135 lb/Acre and organic matter content 2.0%. Standard soil testing methods were used for the above analyses (1). Granular herbicide treatments were applied with a 3-ft drop type spreader. Liquid materials were applied in water from a back-pack sprayer with a fan nozzle delivering 100 gallons per acre at a pressure of 25 pounds per square inch. The experimental design was a randomized complete block with 4 replications and individual plot size of 3 by 10 ft. Commercial and experimental materials had been applied annually from spring 1966 to spring 1972. Experimental materials applied for the first time in the spring of 1972 were only placed on plots containing greater than 50% crabgrass in the fall of 1971 and plots that had been devoid of chemical treatment for a minimum of 4 years. All plots were overseeded with crabgrass in the fall of 1971.

Commercial materials evaluated were bandane (polychlorodicyclopentadiene isomers) benefin (N-butyl-N-ethyl-α , α , α ,-trifluoro-2,6-dinitro-p-toluidine), DCPA (Dimethyl tetrachloroterephthalate, tricalcium arsenate (Ca_3 AsO_4), Bensulide (O, O-diisopropyl phosphoro dithioate S-ester with N-(2-mercapthoethyl) benzenesulfonamide)), and siduron (1-(2-methyl cyclohexyl)-3-phenyl urea). A 820 (N-sec-butyl-5-Tertiary butyl 2,6-dinitro aniline) was experimental and is being released as NO-CRAB. Commercial names of the other materials are: benefin (Balan), DCPA (Dacthal), tricalcium arsenate (Chipcal), bensulide (Betasan, Presan) and siduron (Tupersan). Formulations utilized have been noted in Tables 1 and 2. All materials were applied for the seventh and last time on April 18, 1972 and were not irrigated. Initial germination of smooth crabgrass was observed May 11, 1972.

Results

The best combination of crabgrass control and turfgrass quality was achieved with bensulide, tricalcium arsenate and A-820 2.3G in the 1972 tests (Table 1). Of particular notice in the 1972 test was the failure of the emulsifiable concentrate formulation of A-820 to provide good smooth crabgrass control (Table 1). The granular formulation of this material considerably improved its effectiveness. In this experiment the plots were not irrigated after application of the herbicides. This likely contributed to the loss of efficiency exhibited by liquid formulations and siduron and benefin. Creeping red fescue was absent in the tricalcium arsenate and bandane plots and was notably decreased under the continuous application of DCPA. The 6 lb active ingredient/Acre rate of A-820 visibly yellowed the creeping red fescue but did not visibly harm the Kentucky bluegrass in the stand. The continuous application of bandane to bluegrass-red fescue mixtures is deleterious to turf quality (Table 1.) The bandane plots were severely injured by the repeated applications. The crabgrass control provided by DCPA and benefin was sporadic. By September considerable invasion by smooth crabgrass had occurred.

In July the best turfgrass quality was found in the tricalcium arsenate plots, but by September the quality of the plot was less than acceptable. By September the best turfgrass quality was found in the bensulide plot.

Root counts taken one year after the last application of preemergence herbicide indicate considerable effect of continuous preemergence herbicide application upon root counts at the 3 and 6 inch depth. Bandane and tricalcium arsenate caused the most serious reduction of root number with 83% and 51% reduction, respectively. Benefin, bensulide and DCPA were less severe with 29%, 26% and 12% root reduction respectively. Less severe reduction in root number occurred at the 6-inch depth. This observation is consistent with our understanding of the immobility of preemergence herbicides.

Summary

Seven years of continuous application of preemergence herbicides to Kentucky bluegrass-red fescue turf produced injury with bandane and significant decreases in root number at the 3-inch depth with bandane and tricalcium arsenate. The best combination of crabgrass control and turfgrass quality was provided with bensulide, tricalcium arsenate and A-820.

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1. Bandel, V. A., C. K. Stottlemeyer, and C. E. Rivard, 1969. Soil testing procedure, University of Maryland Soil Testing Laboratory, Agronomy Mimeo No. 37, University of Maryland, College Park, Maryland 20742.

Acknowledgements

The authors wish to express their appreciation for the computer time made available through the facilities of the Computer Science Center of the University of Maryland and to Warren Burkholder, Andrew J. Teutsch and Thomas J. Lavery for their technical assistance.

Table 1. Effect of chemicals on preemergence crabgrass control and turfgrass quality in 1972 at the Plant Research Farm, Fairland, Maryland.

Treatment	Formulation	Rate (lb a.i./acre)	Smooth Crabgrass in Plot 7/21/72 (%)	Smooth Crabgrass in Plot 9/8/72 (%)	Turfgrass Quality 7/21/72 (Rating)[x]	Turfgrass Quality 9/8/72 (Rating)
Bandane[y]	10 G[z]	35	0	0	3.2	2.5
Benefin	2.5 G	2	6	16	6.0	5.5
Ca_3AsO_4	48 G	187	0	0	7.2	5.0
Bensulide	12.5 G	12.5	0	0	6.0	6.5
A-820	4 EC	4	49	51	4.7	5.0
A-820	4 EC	5	62	64	4.2	5.0
A-820	4 EC	6	50	63	5.0	5.0
DCPA	75 WP	9	10	25	6.0	6.0
A-820	2.3 G	4	0	8	6.0	5.7
A-820	2.3 G	5	1	26	6.5	5.7
A-820	2.3 G	6	0	5	5.2	6.0
Siduron	50 WP	12	28	57	5.0	5.0
Check		0	79	80	3.9	5.0
Bayes 5% LSD[w]			11	18	0.9	0.5

[w]Duncan, D. B. 1965. A Bayesian approach to multiple comparisons. Technometrics 7:171-222.

[x]Turfgrass quality ratings made on a 0-9 scale where 9=maximum turfgrass quality, 6=acceptable turfgrass quality and 0=bare soil. Quality estimate includes uniformity, density, texture and smoothness.

[y]Bandane, Benefin, Ca_3AsO_4, DCPA and Siduron were applied annually from 1966-1972 and A-820 only in 1972.

[z]The abbreviations are G=granule, EC=emulsifiable concentrate and WP=wettable powder. The number in front of: G is % active ingredient, WP is % active ingredient and EC is lb a.i./gal.

Table 2. Residual effect of preemergence crabgrass control chemicals applied on April 18, 1972 upon root counts taken at a 3 and 6 inch depth on April 12, 1973[x], Plant Research Farm, Fairland, Maryland.

Treatment	Formulation	Rate (lb a.i./A.)	Root Count/1.8 sq. inches 3 inch depth (Number)	6 inch depth (Number)
Bandane[x]	10 G[z]	35	5.5 a[y]	5.7 a
Benefin	2.5 G	2	22.0 bc	17.2 b
Ca_3AsO_4	48 G	187	15.0 ab	15.7 b
Bensulide	12.5 G	12.5	23.0 bc	14.2 ab
DCPA	75 WP	9	27.2 c	17.5 b
A-820	2.3 G	6	26.5 bc	17.0 b
Siduron	50 WP	12	32.7 c	21.0 b
Check		0	31.0 c	20.8 b

[x]Bandane, Benefin, Ca_3AsO_4, Bensulide, DCPA and Siduron were applied annually from 1966 through 1972 and A-820 only in 1972.

[y]Columnar means with the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range Test.

[z]The abbreviations are G=granule and WP=wettable powder. The number in front of G and WP is % active ingredient.

Performance of Slow Release Fertilizers on Bentgrass Greens

J. R. Hall
Department of Agronomy

Purpose and Objectives

This experiment was designed to observe the effects of five sources of nitrogen fertilizer on the color, density, quality, and rooting depth of Penncross Creeping bentgrass (Agrostis palustris Huds. "Penncross"). The rate of nitrogen release from organic nitrogen sources is variable and knowledge of the differences that exist is essential to the professional turfgrass manager.

Procedure

The sixth green of the Columbia Corporation Running Brook Development, Columbia, Maryland was utilized for this study. The green was being maintained on a minimum nitrogen program when the study was initiated. The green was constructed with a sand-soil-peat mix creating a soil texture of 70% sand, 18% silt and 12% clay. Standard soil tests taken in the fall of 1971 indicated the pH was 7.2, magnesium exchangeable 170 lb/A, phosphorus available 85 lb/A and potassium exchangeable 60 lb/A (1). Phosphorus and potassium fertilizer (0-20-20) was applied at the rate of 1 lb P_2O_5 and 1 lb K_2O/1000 sq. ft. on March 16, 1972, July 17, 1972 and September 28, 1972. Treatments were applied as indicated in Table 1. The greens were irrigated as deemed necessary and maintained at a $\frac{1}{4}$" mowing height. Urea formaldehyde was applied as Uramite (38-0-0), IBDU (isobutylidene Diurea) as Parex (30-0-0), Dried Activated Sludge as Milorganite (6-4-0) and the Tennessee Valley Authority (TVA) sulfur coated urea as a 34-0-0 pelleted material with a solution rate of 15.4% in 3 days, 21.2% in 5 days and approximately 1.4% daily.

The 1-9 rating system was utilized with 9 equal to the darkest green color and the highest quality putting surface. Quality ratings were made

with putting surface quality being the primary determining factor. Color, density, uniformity and smoothness of surface are considered important components of putting green quality. Density counts were made by counting the number of living tillers in a sample randomly removed with a soil probe. Maximum rooting depth measurements were taken on September 28, 1972 by removing a soil core to a 13 inch depth and determining the maximum depth at which living white roots could be seen.

Rates and times of nitrogen application of the different materials were set up to be as equal as practically possible considering the variable rates of nitrogen release.

The experiment had to be abandoned in March of 1973 due to vandalism.

Results

The effect of the March 17, 1972 applications of nitrogen (Table 1) on creeping bentgrass had diminished by May 12, 1972 for urea (Table 2). Activated sludge provided the earliest dark green color in response to the March nitrogen application. It is likely that the dark color of activated sludge increased heat absorption, quickening the soil warming process and, therefore, speeding nitrogen release and color response. The activated sludge provided the best color response until August when the monthly urea treatments provided significantly darker color. The August and September activated sludge applications (Table 1) created significantly higher color responses in October than the other materials (Table 2). Ureaformaldehyde produced significantly higher color ratings than IBDU in June, July and September. This is thought to have occurred as a result of the strong dependency of urea formaldehyde upon soil temperature for nitrogen release. This is supported further by the fact that IBDU produced significantly darker green color than urea formaldehyde during the cooler months of January and March 1973 (Table 2). The color provided by the TVA sulfur coated urea material was unsatisfactory seven out of the eight months ratings

were taken. It is possible that the larger particles present in the TVA material were picked up by the greensmower.

The only treatment producing acceptable quality in May following the March application of treatments (quality rating greater than 5.9) was activated sludge (Table 3). All the other materials were slower to create a response. The activated sludge treatment produced less than acceptable quality only one of the six times ratings were taken (quality ratings less than 6.0). Less than acceptable quality ratings were found on IBDU 6 times, urea formaldehyde 2 times, TVA sulfur-urea 6 times, and urea 2 times. In this study urea formaldehyde produced significantly better quality than IBDU in July and September. All slow release treatments appeared to be in need of reapplication by August 18 (Tables 2 and 3).

Activated sludge produced a significantly greater number of tillers than the TVA sulfur coated urea material. (Table 4) and significantly greater rooting depth than both the IBDU and TVA sulfur-urea material. There was no significant difference in rooting depth between urea, urea formaldehyde and IBDU.

Summary

Under the conditions of this study activated sewage sludge (Milorganite) provided significantly better creeping bentgrass color and quality response over a greater period of time than did commonly used synthetic organic fertilizers. Urea formaldehyde appeared to perform significantly better than IBDU during warm periods whereas IBDU provided better creeping bentgrass color during the cooler periods. The TVA sulfur-urea formulation utilized in this study was unsatisfactory. Good creeping bentgrass quality and color can be obtained with repeated small applications of urea.

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Acknowledgements

The author wishes to thank C. McDonald and A. Cammorata of Columbia Corporation, Columbia, Maryland for providing a golf green for this study and Andrew J. Teutsch for technical assistance. The computer time for this project was supported in full through the facilities of the Computer Science Center of the University of Maryland.

Table 1. Sources of nitrogen and rates and times of application during 1973.

Nitrogen Source	Nitrogen Application Date						
	Mar 17	May 12	Jun 14	Jul 17	Aug 18	Sep 29	Oct 31
	lbN/1000 sq. ft.						
Urea	2	1	1	1	1	1½	1½
Urea formaldehyde	7					8	
Isobutylidene Urea	7					8	
Activated Sludge	4	2			4	5	
TVA Sulfur-Urea	7					8	

Table 2. The effect of nitrogen sources, and timing and rate of nitrogen application upon color of Penncross Creeping bentgrass at various times.

Nitrogen Source	Date							
	12 May 72	17 Jun 72	17 Jul 72	18 Aug 72	28 Sep 72	31 Oct 72	26 Jan 73	28 Mar 73
	Color Rating[a]							
Urea	5.0	7.0	8.0	7.0	7.7	5.0	3.3	4.7
Urea formaldehyde	6.0	5.7	7.0	5.3	7.0	7.0	4.0	5.7
Isobutylidene Urea	6.3	5.0	5.0	4.3	4.7	6.3	6.3	7.0
Activated sludge	7.3	8.7	9.0	5.0	6.7	9.0	6.3	7.0
TVA Sulfur-Urea	5.3	4.0	4.0	5.4	4.7	7.3	4.3	4.7
Bayes 5% LSD	1.9	0.2	1.3	1.5	1.1	0.9	1.3	0.9

[a]Color ratings made on 1-9 scale with 9=maximum dark green color. Any number below 6.0 is considered less than acceptable.

Table 3. The effect of nitrogen sources, and timing and rate of nitrogen application upon the quality of Penncross Creeping bentgrass at various times.

Nitrogen Source	Date						
	12 May 72	14 Jun 72	17 Jul 72	18 Aug 72	28 Sep 72	31 Oct 72	Ave.
	Quality Rating[a]						
Urea	5.7	6.3	7.3	6.3	8.0	4.7	7.0
Urea formaldehyde	5.3	5.7	6.7	6.0	7.0	6.0	6.1
Isobutylidene Urea	5.7	5.3	5.3	5.0	4.3	5.3	5.1
Activated Sludge	7.0	8.0	9.0	5.0	6.0	8.7	7.2
TVA Sulfur-Urea	5.3	5.3	4.7	5.8	4.7	3.3	4.7
Bayes 5% LSD	2.7	1.0	1,0	2.4	0.5	0.7	---

[a]Quality rating made on a 1-9 scale with 9=maximum turfgrass quality and any value less than 6.0 is considered less than acdeptable.

Table 4. The effect of nitrogen sources and timing and rate of nitrogen application upon the number of living tillers on August 18, 1972 and the maximum depth of roots on September 28, 1972.

Nitrogen Source	Living tillers Per 1.8 sq. in. 8/18/72	Maximum rooting depth 9/28/72
	number	inches
Urea	50	10.8
Urea formaldehyde	51	10.0
Isobutylidene Urea	41	10.2
Activated Sludge	61	11.8
TVA Sulfur-Urea	45	9.7
Bayes 5% LSD	15	2.0

Quackgrass Eradication Chemicals

J. R. Hall and J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Quackgrass (Agropyrons repens (L.) (Beauv.) is a serious threat to quality sod production in the State of Maryland. Herbicides currently available have not provided complete control of this noxious weed. This experiment was designed to compare quackgrass control achieved with dalapon (2,2-dichloropropionic acid), pronamide (N-1,1-dimethylpropynyl)-3,4-dichlorobenzamide) and glyphosate (N-phosphoromethyl)glycine) at various rates. Pronamide is trade-named Kerb and glyphosate is trade-named Roundup.

Procedures

The experiment was conducted on a quackgrass infested Manor loam soil (42% sand, 37% silt and 20% clay) located on the Mayne Turf Farms, Montgomery County, Maryland. Soil pH was 5.7; extractable P_2O_5 302 lb/A and extractable K_2O 410 lb/A (1). All applications were applied in water at the rate of 30 gal/A with a CO_2 charged small plot sprayer delivering the material at 30 psi. The experimental design was a randomized complete block with 3 replications and plot size was 10 by 20 ft.

Treatments (Table 1) were applied on June 16, 1972. The quackgrass was approximately 3 inches high and the air temperature was 75°F. All plots were cultivated with a rototiller to a depth of 6 inches on July 12, 1972. On August 10, 1972, 6 lb/1000 sq. ft. of 16-8-8 was applied and 1 lb/A of silvex (2-(2,4,5-trichloro-phenoxy) propionic acid) was applied for broadleaf weed control. On October 6, 1972, the plots were cultivated with a rototiller, fertilized with 2 lb N/1000 sq. ft. from NH_4NO_3 and seeded to a blend of 50% 'Merion' Kentucky bluegrass and 50% 'Pennlawn' Creeping Red Fescue (Festuca rubra L.) at 2 lb/1000 sq. ft.

Data were taken on July 7, 1972, August 18, 1972 and April 19, 1973 to determine the effect of the applied herbicides on quackgrass control. Each observation was recorded as the average of two individual's ratings. Quackgrass tiller counts were made by randomly sampling 4 sq. ft. areas.

Results

The most rapid response to the applied herbicides was achieved with dalapon at 10 lb AI/A and glyphosate at 1.5 and 3 lb Active Ingredient/A (Table 1). On August 18, 1972, approximately 8 weeks after herbicide application and 5 weeks after the first cultivation, there were significant patterns in quackgrass regrowth developing. The expected summer inactivity of pronamide was evident; glyphosate at 1.5 and 3 lb AI/A and dalapon at 10 lb AI/A continued to be most effective. During the first two months of the study glyphosate at 3 lb AI/A produced significantly better rhizome kill than the other materials. Visual observation of the rhizomes in the glyphosate plot revealed brown rhizomes with very dark-brown, localized necrotic internodal regions.

Significant differences in the percent quackgrass control were obtained with the various treatments and it can be noted that glyphosate at 3 lb/A provided better quackgrass control than glyphosate at 1.5 lb/A ($P < .10$) Table 2). A non-orthogonal single degree of freedom linear contrast indicated that glyphosate at rates of 1.5 and 3 lb/A gave slightly better control of quackgrass than dalapon at 5 and 10 lb/A ($P < .25$). No reduction in germination occurred in any plot after the October 6, 1972 seeding with the Kentucky bluegrass blend.

It appears that single applications of these materials will not provide 100% control of quackgrass, even in conjunction with two cultivations. To establish quality turfgrass in an area infested with quackgrass, more than one application of these herbicides is necessary for quackgrass eradication.

Summary

Dalapon at 10 lb Active Ingredient/A and glyphosate at 1.5 and 3 lb/A exhibited good initial knockdown of existing quackgrass. Rhizome kill was greatest with glyphosate at 3 lb AI/A. Data taken on quackgrass regrowth 10 months after initial herbicide application indicated glyphosate at 3 lb/A provided better quackgrass control than the 1.5 lb/A rate ($P < .10$). Quackgrass control with glyphosate at 1.5 and 3 lb/A was slightly better than with dalapon at 5 and 10 lb/A ($P < .25$). Pronamide at 1.5 and 3 lb/A provided inferior quackgrass control.

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1. Bandel, V. A., C. K. Stottlemeyer and C. E. Rivard. 1969. Soil Testing Laboratory, Agronomy Mimeo No. 37, University of Maryland, College Park, Maryland 20742.

Acknowledgements

The authors wish to express their appreciation to the Mayne Turf Farm for land and equipment utilized in these studies and for the computer time made available through the facilities of the Computer Science Center of the University of Maryland.

Table 1. Effect of glyphosate, pronamide and dalapon on quackgrass regrowth.

Treatment	(lb/A.)	Area of plot in Living Grass[z] 7/7/72 (%)	Quackgrass Tillers per 4 sq. ft. 8/18/72 (number)	Rhizome Activity[y] 7/7/72 (rating)	Dead Rhizomes[y] 8/18/72 (%)
Dalapon	5	25 b[x]	17 ab	7.3 b	70 bc
	10	8 a	9 a	6.7 b	68 b
Pronamide	1.5	87 c	26 ab	8.0 bc	48 a
	3	83 c	20 ab	8.3 bc	62 b
Glyphosate	1.5	7 a	5 a	5.0 a	82 bc
	3	0 a	1 a	5.0 a	93 c
Check	0	95 c	39 b	9.0 c	35 a

[x]Columnar means with the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range Test.

[y]Rhizomes were randomly exhumed from each plot and visual estimates of either rhizome activity (0 to 9 scale where 9=maximum rhizome activity and 0=no rhizome activity) or the percent of rhizomes that were dead was recorded.

[z]Visual estimates of the percent of each plot covered by living grass.

Table 2. Effect of applied herbicides upon quackgrass control.

Treatment	Rate (lb/A.)	Quackgrass Control[x] 4/19/73 (%)
Dalapon	5	31
	10	46
Pronamide	1.5	17
	3	27
Glyphosate	1.5	45
	3	82
Check		0

[x]Total number of quackgrass tillers in each plot was determined. Individual control values were calculated.

The Use of Chelated Iron and Nitrogen to Improve Sod Quality

J. R. Hall
Department of Agronomy

Purpose and Objectives

This study was initiated to determine if applications of chelated iron (Fe) and nitrogen (N) to maturing sod could improve post-harvest color, quality, rerooting strength and root regeneration. Iron applications to creeping bentgrass have been noted to enhance root growth and increase carbohydrate content (3). Iron is important in chlorophyll synthesis as a constituent of respiratory enzyme systems. Iron deficiency in Kentucky bluegrass has been noted to produce discoloration (2).

The objectives of this study were:

(1) to determine if Iron and nitrogen applications could improve post-harvest sod quality, color, rerooting strength and root regeneration.

(2) to investigate the strength of the correlations existing between the variables measured.

Procedure

This study was initiated on a 7 month old sod of Merion, Fylking and Pennstar Kentucky bluegrass (1/3-1/3-1/3) under production management at the Summit Hall Turf Farm. The site was located near the Potomac river on the "River Bottom Farm" on a Manor silt loam soil. This soil contained 29% sand, 48% silt and 23% clay. Extractable potassium and phosphorus was at the medium level and organic matter content was 2.6% (1). As of November 1972 the sod had received 5 lb nitrogen/1000 sq. ft. including establishment fertilization. Phosphorus and potassium had been added as recommended by soil test. On November 16, 1972 treatments were applied as noted in Table 1. All materials were sprayed with a CO_2 pressurized sprayer at 35 PSI delivering 50 gallons per acre. NH_4NO_3 was the source of nitrogen and sodium ferric diethylenetriamine

pentaacetate (CIBA Geigy Sequestrene FE 330) was the source of chelated iron. December and January treatments were applied as noted in Table 1 on the 14th and 16th of the month respectively. Air temperature on all 3 dates was less than 50°F and soil temperatures ranged between 35° - 45°F. Experimental design was a randomized complete block with 4 replications. Individual plot size at the site was 6 X 30 feet.

On March 16, 1973 the plots were harvested at a 5/8" cutting depth and transported to the University of Maryland Plant Research Farm. At the farm a 4ft X 4ft plot was installed for post-harvest color and quality ratings. A 1ft X 2ft section of sod was installed over a preconstructed lifting tray made of wood and ½" chicken wire mesh. Twenty eight days after installation the sod was lifted with a tripod-pulley system attached to a scale registering from 0-300 lbs. The trays were lifted from the soil with a steady pull and the maximum force required to break the tray loose was recorded. The transplant soil at the Plant Research Farm was a Chillum silt loam soil. On the day of transplant the pH was 5.9 and phosphorus and potassium extractable was at the medium level with 1.6% organic matter.

After the flats were extracted, long white relatively unbranched roots were visible. A 4.25" diameter cup cutter sample was removed at random from each 1ft X 2ft sod section and these roots were counted and correlated with lifting force (Table 2). Data on color, quality, lift force and number of roots were all taken on April 13, 1973, twenty eight days after sod installation.

Results

The November 16, 1972 application of nitrogen plus 4 oz chelated FE/1000 sq. ft. produced the darkest green color and the highest quality at time of harvest (Table 1). Additional applications of chelated iron appeared to

have no favorable effect upon color or quality. The application of either nitrogen or chelated iron alone produced significantly less color than the combination of materials. The quality of the sod receiving 1 lb N/1000 sq. ft. plus 4 oz chelated Fe/1000 sq. ft. in November was significantly better than the check plot.

There were no significant differences between treatment effects upon lifting force or root number. It was noted, however, that the least number of roots were found in the check plot and the 3 applications of chelated Fe at 4 oz/1000 sq. ft. plus no nitrogen produced 29% more roots than the check.

One of the more interesting observations made in this study was the significant correlation between the number of roots/unit area and the force required to lift the rerooted sod (Table 2). This observation has long been suspected, but to my knowledge had not been substantiated. Strong correlations also existed between the density or color of turf and the quality of turf.

Summary

Single 4 oz/1000 sq. ft. applications of chelated FE coupled with 1 lb N/1000 sq. ft. in November did enhance post harvest sod quality and color. Additional Fe applications did not increase color or quality of the sod. No statistically significant increases in sod rerooting strength or root number could be shown with Fe or nitrogen applications. Although 3 applications of 4 oz of chelated Fe/1000 sq. ft. in November, December and January did increase the number of roots 29% over the check plot this difference was not statistically significant at the 5% level. A significant correlation between the lift force and the number of roots was shown.

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Table 1. Summary of Color and Quality Ratings taken April 13, 1973 from 4' X 4' plots of sod that had been laid March 16, 1973.

Treatment			Rating[b]	
Nitrogen[a] lb/1000 sq. ft.	Chelated Iron oz/1000 sq. ft. Per Application	Time of Iron Application	Color	Quality
1	4	Nov.	8.5	7.5
1	4	Nov., Dec.	7.2	5.5
1	4	Nov., Dec., Jan.	6.5	6.7
1	4	Dec.	6.9	6.0
0	4	Nov., Dec., Jan.	6.5	6.0
1	0	No Iron	6.9	6.0
0	2	Nov., Dec., Jan.	6.0	5.7
0	0	No Iron	6.0	5.2
5% Bayes LSD			1.4	1.8

[a] nitrogen applications made only on November 16, 1972

[b] color ratings made on 0 to 9 scale where 9=maximum dark green color, 6=acceptable color and 0=bleach tan color. Quality ratings made on 0-9 scale where 9=maximum quality, 6=acceptable quality and 0=bare soil.

Components of visual sod quality are uniformity, density, color, smoothness, and texture.

Table 2. Significant correlations at the 5% level between measured variables over all applied treatments (n- 2 = 30)

Variables Correlated		r
Lift Force	Number of Roots	.412
Lift Force	Density of Turf	.422
Color of Turf	Density of Turf	.592
Color of Turf	Quality of Turf	.740
Density of Turf	Quality of Turf	.796

Tee Turf Research

D. T. Hawes
Department of Agronomy

Purpose and Objectives

Golf course tees received intensive traffic and damage as a result of the game's rules requiring the first shot on every hole to be taken from a small area of the tee. If increased traffic resistance can be obtained by a combination of management techniques and mixtures of traffic resistant grasses, then it will benefit golf courses, athletic fields, tennis courts and schools.

The objectives were to evaluate zoysiagrass, bermudagrass, bluegrass and bentgrass alone and in combination as traffic bearing tee turfgrasses -- then to determine management factors that provide the greatest healing potential, quality and traffic resistance.

Procedures

In the early summer of 1973, stolons of 'Meyer' and 'Midwest' Zoysia and 'Tufcote' and 'Tifgreen' bermudagrass were planted at a rate of 4 bushels per 1,000 sq. ft. in a split-split plot design with four replications at the Hopkins Plant Research Farm. All plots received 7 lbs N/1000 $ft.^2$ as NH_4NO_3 during the initial summer's establishment phase. Per cent cover was evaluated August 30, 1973.

In September, 1973, the four warm season varieties were overseeded to a blend of five Kentucky bluegrass varieties and to 'Penncross' creeping bentgrass. Thus warm season and bluegrass combinations will be evaluated and compared to warm season and bentgrass combinations as well as pure stands of each species.

In May of 1974, 1/8-inch of topdressing will be applied over one-half of each replication and for three times each year thereafter. Also a warm

and a cool season nitrogen fertilizer program will be initiated on the above treatments. Plots will be mowed at 3/4-inches in the summer and 1-inch in the winter season.

Results

In view of the fact that no treatments had been applied to the plots in 1973 only the coverage rate of the Zoysia and bermuda varieties can be given at this time. Coverage by August 30th, 1973 was Tufcote 100%, Tifgreen 95%, Midwest 65%, and Meyer 50%. It should be noted that the two Zoysia varieties were planted two weeks before the bermuda varieties. The results are not unexpected, but merely support previous findings. Midwest Zoysia took on a purple coloration in the fall which was quite noticeable.

After heavy vertical mowing in preparation for overseeding with cool season grasses, it was observed that the Zoysia varieties did not lose as much stolon and leaf material as the bermuda varieties. Recovery from this operation was faster for the Tifgreen than the Tufcote bermudagrass.

Summary

The establishment of this long term experiment proceeded as expected with the bermudagrass varieties establishing much faster than those of Zoysia. Somewhat unexpected was the quicker recovery of Tifgreen than Tufcote from heavy vertical mowing.

Effect of Sucker Control Agents, Method of Application and Time of Harvest on Maryland Tobacco

J. H. Hoyert
Department of Agronomy

Purpose and Objectives

Maryland growers have converted to the use of sucker control chemicals in the past few years. There are practical problems in the application of suckering agents brought on by the reliance of many large growers on custom operators. It is necessary for the custom operator to treat the grower's total tobacco acreage in one visit as it would be too costly to make repeat visits to the farm. It is often impossible for the grower to top his entire crop before the applicator visits because of labor restrictions. Thus there are practical advantages for custom operators to apply sucker control agents to untopped tobacco.

Another problem resulting from decreased labor availability is that tobacco is now harvested over longer periods of time after topping which could have a significant effect on quality and yield. Maryland leaf is noted for its thin body and high filling power — quality characteristics that must be preserved.

Systemic sucker control agents are most popular in Maryland but contact type chemicals have some place on small crop acreages. Combinations of systemic and contact sucker control agents have proven profitable in the flue-cured area and should be investigated under Maryland conditions which are considerably different than flue-cured.

Consequently this study was initiated to compare sucker control agents and different methods of application. The objectives were:

1. To compare chemical suckering agents and various methods of application of these suckering agents and their effect on sucker control, yield, price and acre values of Maryland tobacco.
2. To determine the effect of time between treatment and harvest for various sucker control methods on yield, price and acre values and sucker control.

Procedures

This experiment was located on a Monmouth fine sandy loam at the Tobacco Experimental Farm. Md. 10 variety was transplanted at a population of 6,223 plants per acre with 70-120-180 lbs. of fertilizer broadcast per acre. Four replicates were used in a split plot design with the time of harvest as whole plots and sucker control methods as the sub plots.

Transplanting was carried out on June 8, 1973 and topping was completed August 7, 1973 when approximately 70% of the plants showed open flowers.

Treatments were:

1. Control — Topped August 7, 1973 with no sucker control used.
2. Systemic — Topped August 7 and sprayed with MH-30 at 1 pint per 1000 plants.
3. Systemic — MH-30 at 1 pint per 1000 plants sprayed on August 2 and topped August 7.
4. Contact — Topped August 7 and Off-Shoot-T applied.
5. Sequential — Off-Shoot-T applied August 2, topped on August 7 and sprayed with MH-30.

There were two harvest dates of August 17, 1973 and August 27, 1973. At the time of harvest suckers were removed from the plot and weighed and counted to determine the effectiveness of sucker control.

Yield, price per pound and acre values were computed for the cured leaf using the standard grades as established by Tobacco Division of the Consumer and Marketing Service of the U. S. D. A.

Results

Rainfall was near optimum during the early part of the 1973 season with some dry periods at topping time and sucker growth was about average. The 1973 results are summarized in Table 1.

Measurement of both sucker numbers and weights were much greater for the control treatment than any of the suckering agents. There was greater sucker growth when maleic hydrazide was applied before topping than for the other suckering agents. The contact suckering agent gave poorer sucker control than the other agents tested.

All suckering agents and methods resulted in higher yields than the control treatment. The later harvest date gave considerable more yield than the earlier date. This difference was particularly true where sucker control was over 70% for the later harvest date. In these cases; MH-30 before topping, MH-30 at topping and contact + MH-30 there was an increase of 235 pounds of tobacco per acre between the early and late harvest dates.

There was no appreciable effect on price per cwt. of the cured leaf by either suckering methods or time of harvest. Acre values were higher for all suckering agents than for the control treatment.

Summary

All suckering methods resulted in higher yields and acre values of cured leaf than the control treatment. Sucker control was better for all suckering methods than the check treatment. There were more suckers present where maleic hydrazide was used before topping than for the other suckering agents used. The contact suckering agent was less successful in controlling suckers than the other suckering agents tested. The late harvest date resulted in higher yields and acre values than the early harvest.

Table 1. Effects of sucker control treatments and time of harvest on sucker weight, yield, price and acre values of Maryland tobacco. 1973.

Treatment	Yield /Acre Lbs	Price $/Cwt	Acre Value $/A	Suckers % Control	Suckers Weight /Plot Lbs	Suckers Number /Plot
Between Chemical Treatments						
1. Control	1273	80.68	1027	0	8.53	147
2. Maleic hydrazide at topping	1417	79.82	1141	89	0.90	34
3. Maleic hydrazide before topping	1430	79.95	1143	73	2.26	45
4. Contact	1359	79.84	1086	36	5.50	76
5. Contact before topping maleic hydrazide at topping	1504	80.31	1209	95	0.43	18
Between Dates of Harvest						
August 17, 1973	1325	79.42	1056		0.76	46
August 27, 1973	1469	80.82	1186		6.28	82

The Feasibility of Transplanting Tobacco Seedlings in Pressed Peat-Soil Cubes

J. H. Hoyert
Department of Agronomy

Purpose and Objectives

The purpose of this research was to develop new methods of growing tobacco plants which would have a potential for improving seedling uniformity. Thus, if successful, further mechanization of transplanting and a reduction in labor might be achieved. Irregular tobacco at harvest time in part because of non-uniform transplants is one of the major problems in total mechanization of tobacco production.

The objectives of this study were:

1. To compare the growth and uniformity of transplants in pressed peat-soil cubes to conventional transplants.
2. To investigate the feasibility of discontinuing the use of water with peat-soil cubes.

Procedure

This experiment was situated on a Monmouth sandy loam soil at the Tobacco Experimental Farm. Md. 609 variety was transplanted using a modified Ellis 2-row mechanical transplanter at a plant population of 6,223 per acre. Fertilizer was broadcast at a rate of 60-120-180 lbs. per acre. Experimental design was a randomized complete block with 4 replicates. Plots were 1-row of 32 plants or 3 by 74.6 ft. in size with 30 plants harvested.

Treatments included were pressed peat-soil cubes and transplants pulled from a plant bed and carefully sorted and selected according to uniformity of size and shape. The control consisted of conventional trans-

plants pulled rapidly as an average grower would draw seedlings with no extra attention given to uniformity. Each of these treatments was transplanted with 1/2-pint of water placed at the roots during the planting operation. The three treatments were also repeated with no water used at transplanting making a total of six treatments.

Transplanting was carried out on June 4, 1973. This period was one of adequate and well distributed rainfall and soil moisture was at an optimum level. Harvesting was completed on August 8, 1973.

Ratings of early growth, vigor and uniformity were made 3 weeks after transplanting by four observers on a 1 to 10 basis with 10 being a perfect plot. Yield per acre, price per hundredweight and acre values were also determined.

Results

The field results are presented in Table 1 and indicate that under the conditions of ideal soil moisture at time of transplanting there were no significant differences between any of the treatments for early growth ratings. Trends in yields indicated higher yields of tobacco per acre resulting where water was used at transplanting. On the average the use of water resulted in an 8.3 per cent yield increase in 1973. Price per pound appeared somewhat higher where water was used but wasn't conclusive. Acre values were higher by $237 when water was used with the peat-soil cube and $212 greater for the specially selected transplant. The average of the three treatments with water was $165 per acre greater than the same three treatments with no water.

Summary

The peat-soil cube performed satisfactorily under the conditions of this test and were agronomically feasible as shown by early growth, yield, price per pound and acre values. The use of water consistently resulted in higher yields, price per pound and acre values for all treatments. There were no significant differences between treatments in ratings of early growth.

Table 1. Yield, price, acre value and early growth rating of various types of tobacco transplants, 1973.

Treatment	Yield lbs/A	Price $/cwt.	Value $/A	Rating of early growth *
(with water)				
Control	2011	83.53	1680	7.50
Peat-soil cube	2142	83.49	1788	7.25
Selected plant	2120	83.67	1773	8.25
(without water)				
Control	1994	81.87	1633	7.00
Peat-soil cube	1917	80.90	1551	5.75
Selected plant	1877	83.11	1561	7.50
L.S.D. (.05)	181	1.88	159	N.S.
(.01)	N.S.	N.S.	N.S.	N.S.
C.V.	6.0%	1.5%	9.6%	

* Rating of 1 to 10 with 10 being optimum.

Regional Tests With Tobacco Sucker Control Agents on Maryland Tobacco

J. H. Hoyert and G. L. Steffens
Department of Agronomy and
Plant Physiology Institute, U.S.D.A.

Purpose and Objectives

Plant growth regulators have been used to inhibit the growth of tobacco suckers in all types of tobacco. However, some undesirable effects on the chemical and physical properties of the tobacco and possibly the health of consumers have been suggested. Consequently, studies have been going on for some time on a regional basis to find other chemicals and methods of sucker control which would be more suitable. (This approach has been through the Regional Tobacco Growth Regulator Committee which involves 10 states, U.S.D.A., EPA, many chemical companies, most of the domestic tobacco companies and one foreign tobacco company. This regional research was instigated by the U. S. House of Representatives).

Maryland is a participant in this regional research and the report herein will deal with 1973 results in Maryland to determine the effectiveness of several sucker control agents on tobacco yield, price, acre values and sucker control.

Procedure

The experiment was conducted on a Monmouth fine sandy loam at the Tobacco Experimental Farm. Md. 10 variety was transplanted on June 8 with 75-120-180 lbs. of fertilizer broadcast per acre. Topping was completed on August 7 when 90% of the plants showed at least some open flowers. Suckers were removed after 14 days, counted and weighed. The control

treatment which was not suckered served as a basis for calculating the percent sucker control. Treatments studied were: control, maleic hydrazide, Off-Shoot-T, American Cyanamid-553 and 72-A45.

Results

Significantly higher cured leaf yields and acre dollar values were obtained from tobacco treated with all of the sucker control agents as compared to values from the untreated control as shown in Table 1. There were no significant differences in the price per hundredweight between any of the treatments. However there was a slightly higher price trend for tobacco from the untreated control plots. Control of suckers was excellent for all suckering agents when compared to the untreated check. Percent control ranged from 89 to 97 percent. There were no leaf injury symptoms observed for any of the treatments in 1973. Phytotoxic effects frequently occur with the use of some suckering agents.

Summary

Regional sucker control tests were conducted on Maryland tobacco to determine the effectiveness of various suckering agents on degree of sucker control, yield, price and acre values of tobacco. All of the suckering materials gave very satisfactory control. Significantly higher yields and acre values resulted from all chemicals tested when compared to the untreated check. There were no important differences in price per hundredweight for tobacco from any of the treatments including the control treatment.

Table 1. The Effects of Sucker Control Treatments on Sucker Growth, Cured Leaf Yield and Price — Maryland Tobacco Advanced Regional Tests. 1973.

Treatment	Sucker Growth				Cured Leaf		
	Sucker Control 1/ %	Weight /Plant gms	Weight /Sucker gms	Suckers /Plant No.	Yield /Acre Lbs	Price $/Cwt	Acre Value $/A
Control	0	137.0	16.9	8.1	1267	87.60	1111
MH	97	2.3	1.6	1.4	1402	86.75	1217
OST	96	4.2	11.4	0.3	1421	87.32	1240
AC-92553	89	15.6	9.8	1.7	1372	86.72	1191
72-A45	96	5.0	10.2	0.4	1456	86.03	1253

1/ % by which treatment reduced sucker green weight compared to check.

The Use of 2-Chloroethylphosphonic Acid (CEPA) to Improve Maturity of Maryland Tobacco

J. H. Hoyert
Department of Agronomy

Purpose and Objectives

There is need for work on reducing the range of maturities between the lower and upper leaves of the tobacco plant at harvest time. Maryland tobacco is stalk-cut at that critical time when the middle leaves are of optimum ripeness, the lower leaves are overmature and the top leaves are immature. This wide range is a limiting factor to new procedures of harvesting and curing being developed for labor reduction. The chemical growth regulator 2-chloroethylphosphonic acid had shown some promise in previous observations of improving maturity. It was thought that further work was desirable with this material. This chemical will be listed herein as CEPA and is now labeled as Ethephon.

The objective of this study was to compare the effect of maturity at time of application upon the yield, price, and acre values of cured tobacco when treated with CEPA.

Procedure

This study was located on a Monmouth sandy loam soil at the Tobacco Experimental Farm. Md. 609 variety was planted at a population of 6,223 plants per acre with 60-120-180 lbs. of fertilizer broadcast per acre. Plots were planted on June 4, 1973 and topped on July 30, 1973 with a contact chemical used as a sucker control agent. Four replicates were used in a split plot design with chemical treatment as whole plots and time of harvest as the subplots. Maturity was studied by harvesting at four different dates. Harvest dates were; August 3, 13, 18 and 24. Thus there were 4, 14, 19 and 25 days, respectively, between topping and harvest.

Chemical treatments were CEPA applied at the rate of 75 mg per plant and a control with no CEPA applied.

The chemical was added to water to bring total volume up to 20 ml per plant and sprayed in a fine mist over the entire plant. The test was designed to be harvested 4 days after treatment with CEPA. The variation in time of application was to determine the effect of maturity of the plant upon response to CEPA.

Results

Table 1 presents the yield, price, and acre values of tobacco in 1973. Yield, price, and acre values were decreased at the August 3 harvest date. This early harvest date resulted in small immature leaves in the upper part of the plant. The general trend from first harvest date through the last date of harvest show slight increases in yield, price per hundredweight and acre values. This trend is believed to be because of maturity. The August 13 harvest date (treatment b) was unexplainably higher than expected from the trend. There were small increases in yield, price, and acre value where CEPA was applied when compared to the control. These increases were too small to be of any practical benefit to growers.

Yellowing of leaves was noticed after the CEPA application from the second treatment through the last treatment giving the plant a "ripe" appearance. Curing of matured tobacco treated with CEPA was about 5 to 7 days earlier than the untreated tobacco. However the midribs of the leaf did not dry any faster than the control tobacco.

Summary

The application of 75 mg per plant of CEPA caused a yellowing of the treated leaves of mature plants. The immature plants of treatment a did not yellow as a result of CEPA applications. CEPA treated mature tobacco "yellowed-down" uniformly and completely within 3 days in the curing barns and the leaf lamina cured 5 to 7 days earlier than untreated tobacco. Midribs of these leaves dried at the same rate as the untreated tobacco. This increased curing rate would offer a potential in mechanization of allowing the curing facility to be used twice in a single season.

Trends indicate that increased maturity improved tobacco yields, price, and acre values. CEPA application resulted in modest but not economically important increases in yield, price, and acre value.

Table 1. Effect of CEPA on yield, price, and acre values of Maryland tobacco. 1973.

Harvest Date	Yield /Acre Lbs	Price $/cwt	Acre Value $/A
Between Harvest Dates			
a. August 3, 1973	1750	80.32	1405
b. August 13, 1973	2037	83.35	1647
c. August 18, 1973	1884	84.47	1592
d. August 24, 1973	1974	84.48	1668
Between Chemical Treatments			
1. Control (0 mg)	1898	82.94	1576
2. CEPA (75 mg)	1924	83.37	1580

Field Testing for Lodging Resistance of Maryland Tobacco Varieties with Artificially Produced Wind

C. G. McKee and M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

Md. 609 tobacco variety is planted on about 60% of the total tobacco acreage in Southern Maryland. This variety produces good yields of high quality tobacco, but it is very susceptible to lodging in wind squalls. This created a lot of interest among growers for developing a new variety similar to Md. 609, but with better resistance to lodging. Lodging resistance is difficult to determine in normal testing procedures unless you have a test planted in an area that had a wind squall. Therefore, the purpose of this study was to investigate the potential of using wind making machines to test the lodging resistance of tobacco varieties.

Procedure

Three Maryland varieties, Md. 10, Md. 609 and Md. 64, with some known history of root system and lodging resistance and one Md. 609 type breeding line, BL 872, were planted in a field test. Single row plots were used with 8 replications. When the plants had started to flower a John Bean Rotomist 100 mist blower sprayer was used to provide "wind" to blow directly into the single row plots. Estimates of the angle of lean of the individual plants were then made.

Results

The tobacco plants leaning less than 15 degrees from perpendicular after treatment were not considered to be lodged enough to be of any problem at harvest. Table 1 shows the percentage of plants of the varieties and breeding line that were leaning 15 degrees or more after the wind treatment. Breeding line 872 showed a significantly higher resistance

to lodging than Md. 609 which was one of its parents. It behaved similarly to Md. 64, a variety considered by growers to have a high resistance to lodging. Md. 10 was intermediate in resistance to lodging compared with Md. 609 and Md. 64 in this test. This is consistent with what has been observed over the tobacco producing area.

Summary

The mist blower sprayer appears to be a very satisfactory device for generating wind to field test the lodging characteristics of Maryland tobacco varieties. Breeding line 872 which showed a high resistance to lodging in field tests using the artificially produced wind and meeting all normal qualifications for release was released to Maryland tobacco growers for the 1974 season as Maryland 872.

Table 1. Percentage of tobacco plants leaning 15 degrees or more after blowing with artificially produced wind.

Variety	% Leaning over 15 degrees
Maryland 10	36
Maryland 609	43
Maryland 64	7
Breeding line 872	7
L.S.D. (.05)	15
(.01)	20

Irrigation with Maryland Tobacco

C. G. McKee
Department of Agronomy

Purpose and Objectives

Presently between 15 and 20% of the Maryland tobacco crop can be irrigated if needed. Supplemental water is not necessary every year, but in some seasons the crop value can be doubled. Thus, the objective of this experiment is to gather long term data on the benefit of irrigation to the production of Maryland tobacco and to determine if there is a differential variety response to irrigation.

Procedure

The experiment was a split plot design. Main plots were varieties — Md. 10, Md. 609, Md. 64, Md. 872, Md. 201, and breeding line J-1F-1. There were six replications for a total of 72 plots.

The test was located at the University of Maryland Tobacco Experimental Farm. The soil was Monmouth fine sandy loam. The fertilizer application was 90 lbs. N, 120 lbs. P_2O_5 and 180 lbs. K_2O equivalent per acre.

Water was applied to the plots requiring irrigation when the plants started to show moisture stress in the heat of the day. A Skinner overhead pipe system was used for irrigation.

Fifteen plants were harvested and cured from each plot. The cured plants were stripped into farmer grades, weighed, U.S.D.A. grades assigned and priced according to grade. Per acre yield and value was then calculated. A representative sample of the cured leaves from the whole plant was taken for chemical analysis and a leaf from the mid portion of the stalk of each plant was saved for leaf burn and filling capacity tests.

Plants were transplanted into the field on June 8. One irrigation of about $1\frac{1}{4}$ inches of water was applied on August 13. The plants were topped on August 16 and harvested on August 24.

Results

The results for irrigation on tobacco in 1973 are given in Table 1. Irrigation generally improved both yield and quality of the cured leaf. Thus, there was an overall average increase in gross dollar return of $84 per acre. However, there was variation between varieties ranging from plus $2 to plus $210. Irrigation had very little affect on leaf burn, filling capacity, % total nitrogen and % total alkaloids.

Summary

The 1973 growing season was considered to be relatively good for tobacco. One irrigation was applied just prior to topping. This resulted in an increase in yield and quality of cured leaf, but it had little effect on the physical and chemical properties measured.

Table 1. Summary of tobacco irrigation test — 1973

Treatment and Variety	Yield/Acre lbs.	Cents/lb.	$/Acre	Burn seconds	Filling Capacity cc/gm	% Total Nitrogen	% Total Alkaloids
Irrigated							
Md. 609	1711	83.6	1434	9.3	6.2	2.10	2.16
Md. 10	1398	81.1	1134	7.8	6.7	1.72	1.61
Md. 64	2009	81.0	1627	9.0	6.8	1.83	1.80
Md. 872	1873	82.6	1550	8.5	7.5	2.01	1.75
Md. 201	1723	81.4	1403	7.1	7.2	1.83	1.87
B.L. J-1F-1	1641	81.0	1331	4.5	7.0	1.99	1.82
Not Irrigated							
Md. 609	1678	82.6	1384	11.4	6.2	2.26	2.16
Md. 10	1378	80.2	1106	7.3	6.7	1.91	1.76
Md. 64	1772	79.9	1417	10.4	6.5	1.86	1.78
Md. 872	1714	80.9	1388	8.2	6.9	2.10	1.82
Md. 201	1714	81.7	1401	6.2	6.4	1.90	1.94
B.L. J-1F-1	1604	79.7	1278	6.4	6.8	1.98	1.87
Ave. Irrigated	1726	81.8	1413	7.7	6.9	1.91	1.83
Ave. Not Irrigated	1634	80.8	1329	8.3	6.6	2.00	1.89
Advantage from Irrigation							
Md. 609	+ 33	+1.1	+ 50	-2.1	0	-.16	0
Md. 10	+ 20	+ .9	+ 28	+ .5	0	-.19	-.15
Md. 64	+237	+1.1	+210	-1.4	+.3	-.03	+.02
Md. 872	+158	+1.6	+162	+ .3	+.6	-.09	-.07
Md. 201	+ 9	- .3	+ 2	+ .9	+.8	-.07	-.07
B.L. J-1F-1	+ 37	+1.3	+ 53	-1.9	+.2	+.01	-.05
Average	+ 83	+1.0	+ 84	- .6	+.3	-.09	-.06

Response of Corn to Various Tillage Practices

F.P. Miller
Department of Agronomy

Purpose and Objectives

The purpose of this study is to evaluate the response of corn to several methods of soil preparation and tillage. The tillage practices include plow-planting and no-tillage planting under several conditions, viz., no pre-preparation, disking ahead of the no-tillage planter, and plowing - disking ahead of the no-tillage planter.

Because of the difficulty in establishing a cover crop for no-tillage corn (due to the winter geese population) on the Eastern Shore, Farmers are interested in the possibility of using the no-tillage system in the previous year's stover without a cover crop. This study is designed to investigate this possibility. Furthermore, the long term effects of applying fertilizers on these no-till plots without incorporation through plowing is being investigated.

After six years of subsoiling these plots at three spacings, the 1973 study was the first year corn was planted in these plots without subsoiling. The objective here is to determine if there are any aftereffects of subsoiling these medium textured soils.

Procedures

This study is located at the Wye Institute on the Bertie silt loam (somewhat poorly-drained) and Mattapex silt loam (moderately well-drained) soils. Four replications were used throughout and the plot size was 50 x 20 feet. The corn variety was Pioneer 3369 planted in 30 inch rows on May 7. The no-tillage corn (including a check, disk-plant and plow-plant treatment) was planted with a modified four-row I.H. planter, and a four-row J.D. planter was

used for the conventionally planted corn (including a check, plow-plant, and previsouly subsoiled treatments).

All plowing and disking was done on the day of planting. The plots to be planted with the no-tillage planter were either left untreated (no-till), disked only, plowed only (plow-plant), or plowed and disked (check). The plots to be planted with the J.D. conventional planter were either plowed and disked (check and previously subsoiled plots), or plowed only (plow-planted).

Fertilizer was broadcast on all plots (including the no-till plots) prior to plowing at the rate of 136-68-68 (lbs per acre of $N-P_2O_5-K_2O$). An application of 20-40-40 (lbs per acre of $N-P_2O_5-K_2O$) was made in the row on those treatments employing the conventional planter. Therefore the total fertilizer application rates for each planter were as follows:

Planter and Treatment	Fertilizer Applied (lbs/acre) N	P_2O_5	K_2O
Conventional planter: (J.D.) check, subsoiled and plow-plant	156	108	108
No-till planter: (I.H.) no-till, plow-plant, disk plant, check	136	68	68

A combination herbicide was applied to all plots on May 7 at the rate of 1.5 pounds of atrazine (AATREX) and 1.5 pounds of simazine (PRINCEP) per acre. Although no cover crop was planted on the no-tillage plots, a heavy infestation of chickweed was present along with the residue and corn stover from the previous year's crop. These no-tillage plots, in addition to the aforementioned herbicide treatments, received an application of paraquat at the rate of 0.5 pound (one quart) per acre on May 1. The no-tillage corn was planted into the previous year's stover and indigenous weed cover.

Results

The results for the 1973 test on the previously subsoiled plots and the plow-plant treatments are presented in Table 1. The data also include the yields for the period 1967-72.

The low yields are mainly due to reduced plant populations caused by bird damage after planting. Although the 1973 plots were not subsoiled, they yielded about 15 bushels per acre less than the check plot. This same trend has occurred in previous years and is thought to be due to increased compaction from the subsoiling operation. It appears that the aftereffects of the subsoiling operations are still evident a year after they were terminated. For a more intensive discussion of this subsoiling project, the reader is referred to the 1972 Crops and Soils Research report.

The plow-plant treatment still appears to be an alternative on these silty soils. After six years of this continuous treatment (Table 1), only slight yield reductions have been noted when compared to the check. This treatment will be continued.

The no-tillage treatment data are presented in Table 2. Again, the generally low yields are the result of bird damage after planting which lowered the plant population.

Although the no-till yields are lower than the check, it does appear that the no-tillage method does have potential even without a cover crop. Where the corn stover residue and/or indigenous weed cover (e.g. chickweed) are heavy, it appears that a cover crop is not necessary. However, yield reductions have been greatest under no-tillage where the soil cover has been sparse. Fall panicum is still the major weed in these plots but it does not pose a major problem at this time. The herbicide combination appears to keep it under control until the crop is made.

The comparison of the planting methods on the chemical environment of the soil is of interest to the farmer and is one of the objectives of this study. Because fertilizers are not incorporated into the soil under the no-tillage system, the nutrient content of the surface builds up over the years. This situation is demonstrated by the soil test results in Table 3.

The soil test results in Table 3 are reported on an acre-furrow slice basis for each sample and have not been corrected for the 1, 2, or 3 inch sample increments. The sample is a composite of several samples taken from three reps. These data are consistent with previous analyses which show the conventional system having higher fertility indices. While previous analyses have included some reps where a conventional planter has been used (with some fertilizer placed in the row - thus accounting for some of the higher fertility), perhaps the sampling procedure of taking the top inch is not incremental enough to adequately sample the surface nutrient distribution under no-tillage.

The plots were limed a month prior to sampling at the rate of 1.5 tons per acre. Although the surface quarter inch of soil was scraped away, there probably has been some contamination of the 0-1 inch sample by fresh lime.

For the Mg, P_2O_5, and K_2O analyses, it is evident that after five years of not plowing the no-tillage treatment, these nutrients are concentrating at the surface. The nutrients are more uniformly mixed within the 0-7 inch plow layer of the conventionally treated plots. These data substantiate the fact that continuous no-tillage corn will result in concentrating the nutrient elements in the upper part of the root zone. The different moisture and temperature regime under no-tillage crop production may offset any deleterious effect this concentration might have on corn yields. This situation will continue to be monitored.

Summary

After six years of subsoiling these soils, no beneficial effects have been noted as measured by corn yields. On the contrary, there has been a trend toward reduced yields, probably due to compaction under the heavy draft load. This influence has been noted on these soils the year following termination of the subsoiling treatments.

No-tillage corn production on these soils without a cover crop appears to be feasible only if a heavy corn stover residue and/or weed infestation provide adequate soil cover. After five years of production, observations and yield data have indicated that the no-tillage plots have yielded as well as the conventionally planted plots in three out of the five years.

The fertilizer nutrients are concentrating near the surface of the no-tillage plots after five years without plowing or nutrient incorporation.

Table 1. Average corn yields for the period 1967-73 for four soil management treatments - Wye Institute, Maryland

Treatment	Average yield (bu/acre)							
	1967	1968	1969	1970	1971	1972	1973*	Mean
Check	112	118	130	122	125	112	105	118
Subsoiled 22 inches	115	105	103	101	97	98	90	101
Subsoiled 44 inches	115	116	123	97	115	94	90	107
Subsoiled 80 inches	112	98	113	116	106	93	88	104
Plow-planted	-	98	120	120	114	105	98	109

*The 1973 plots were not subsoiled, but were recorded separately to determine any aftereffects of the previous six years subsoiling.

Table 2. Average corn yields for no-tillage treatments as compared to conventional planting - Wye Institute, Maryland

Treatment	Average yield (bu/acre)					
	1969	1970	1971*	1972	1973	Mean
Check;plowed,disked	125	110	88	94	98	103
Disked only	131	120	65	90	91	100
No-tillage (stover)	136	102	71*	100	86	99

*In 1971, a rye cover crop was planted in the fall of 1970. To simulate no-tillage planting with no cover crop, the rye was cut and removed. The corn was then planted into the rye stubble. Where the corn was planted into the rye cover crop, the yield averaged 112 bu/acre. The low yields resulted primarily from poor stands caused by the no-tillage planter being adjusted for planting in a cover crop.

Table 3. Soil test results on incremental depth samples under conventional vs. no-tillage corn after five years: Sampled 5-3-73.

Depth (in.)	pH		Mg		P_2O_5		K_2O	
	Conv.	No-till	Conv.	No-till	Conv.	No-till	Conv.	No-till
			lbs/acre					
0-1	5.9	6.4	136	258	260	300	216	216
1-3	5.9	5.6	118	108	185	130	153	132
3-5	6.2	5.6	160	84	185	90	168	111
5-7	6.2	5.8	172	92	225	90	117	96
7-9	6.4	6.1	124	106	95	75	111	81
9-12	6.6	6.3	114	120	15	60	72	66
12-15	6.7	6.3	114	134	10	30	48	51
15-18	6.5	5.9	162	142	5	5	33	30

Correlations of Air Pollution Damage on Maryland Tobacco Cultivars and Hybrids with Certain Agronomic, Chemical and Physical Properties of Cured Tobacco

Rosanna Hsieh, C. L. Mulchi and M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

Greenhouse and field studies on the effects of air pollution, weather fleck, on Maryland tobacco cultivars have shown that a wide range in tolerance to air pollution exists among cultivars. In an effort to further characterize these cultivars for their tolerance to air pollution under field conditions and to obtain information on the effects of air pollution on agronomic characteristics such as yields, price and value; total alkaloids, total nitrogen, filling capacity and burning characteristics, studies were conducted at three locations in southern Maryland during 1972.

Procedures

The field study consisted of a diallel set of crosses containing eight parent cultivars (Catterton, Wilson, Gertz, Moore, Md.59, Md.10, Md.64, Md.609) and their twenty-eight hybrids. The hybrids were obtained by crossing the parent varieties in all possible combinations excluding reciprocals. The three field locations were Upper Marlboro, Davidsonville and Dentsville, which are approximately 15 miles east-southeast, 23 miles east and 50 miles south-southeast of Washington, D. C., respectively. A randomized complete block design with three replications was used at each location. Fertilizer applications were consistant with soil test recommendations. Each plot consisted of a single row with twenty-five plants spaced two feet apart. Established cultural practices were followed in the growth of the plants.

In mid-August, weather fleck ratings were made on 10 competitive plants within each plot. Fifteen leaves on each plant beginning at the bottom, were scored on a basis of one to five. A one, represented a leaf free of

fleck symptoms while a five represented severe flecking over the entire leaf surface. The score for each plant ranged from 15 to 75.

In late August, ten plants per plot were harvested and placed in barns for curing. Upon curing, the leaves from each plot were stripped from each stalk and separated into lots possessing similar physical properties. Yields (lbs/A) were determined by weighing each lot and adjusting to an acre basis based on plant populations. The average price for the tobacco in each lot was determined by having a representative from the Tobacco Grading Service, Tobacco Division, U.S.D.A., grade each lot. The average market price for the grade over the period from 1969 to 1971 was used to calculate the average price for the plot. The value per acre ($/A) was determined by summing the products of each particular lot weight and average price over the entire plot. The overall average price for the tobacco in each plot ($/100 lbs) was determined by dividing the value ($/A) by the yield (lbs/A) times 100. Conditions during the processing of the tobacco were maintained at $20 \pm 2^{o}C$ and $75 \pm 5\%$ R.H.

During the stripping process, a composite sample of tobacco was taken from each plot. It was obtained by taking a subsample of tobacco on a random basis from each lot on a proportionate weight basis. The subsamples were combined, dried at $70^{o}C$, ground in a Wiley Mill using a 1mm sieve and sealed in glass containers. The tobacco samples were analyzed in the Tobacco Chemistry Laboratory for total alkaloids using procedures developed by Griffith (1957) and for total nitrogen contents using micro-Kjeldahl procedures described by Gains (1971).

A ten-leaf sample of tobacco from the "bright grade" (central stalk position) was selected at random from each plot for burn and filling capacity measurements. Burn measurements were made by placing each leaf on a glowing electrical coil and the number of seconds the leaf would burn were

recorded. The electrical coil was approximately one-half inch long and one-eighth inch wide. An average burn per leaf in seconds was calculated for each plot. Filling capacity measurements employed procedures described by Artho, et al., (1963). An average was calculated in cm^3/g of shredded tobacco for each plot.

Results

Information in Table 1 summarizes the means over three locations for weather fleck ratings, yields, prices, values, total alkaloids, total nitrogen, filling capacity and burn measurements for each of the 36 cultivars and hybrids. All characters except filling capacity and burn duration were found to be significantly different among the 36 entries.

Among the parent cultivars, Catterton and Md.59 expressed the highest weather fleck ratings and Wilson showed the lowest rating for damage. All other cultivars appeared intermediate in tolerance. Among the hybrids, the highest ratings for air pollution damage was expressed by crosses of either Catterton or Md.59 with cultivars showing intermediate to low levels of tolerance to air pollution. The Catterton x Md.59 cross showed the highest damage of all entries in the study.

Of major interest in this study were the relationships of air pollution damage expressed by the plants and various agronomic, chemical and physical properties of the cured tobacco. Results shown in Table 2 summarize the phenotypic correlations of weather fleck damage with each of the characters listed in Table 1 for each of the three locations. There were highly significant negative correlations between weather fleck and yields and value at Dentsville and supporting trends for each at the other two locations. There were significant negative relationships between weather fleck damage and price at all three locations. These results support the concept of high incidence of air pollution damage reducing yields, value

and quality of tobacco.

Total alkaloids, total nitrogen, filling capacity and burning qualities are all important commercial characteristics of cured tobacco. The total alkaloid contents in the composite samples were found to be negatively correlated with air pollution damage at Davidsonville and a supporting trend for such was noted at Dentsville. Total nitrogen contents in the composite samples showed no significant relationships with weather fleck. Both filling capacity and burning qualities were found to be highly correlated with weather fleck damage in a positive manner at single locations with supporting trends evident at the other locations. These results would suggest that morphological characteristics such as thinness of leaf which give high filling capacities and good burning qualities to Maryland tobacco are also associated with the susceptibility of the plants to air pollution damage.

Summary

In a study involving 36 Maryland tobacco cultivars and hybrids at three locations in southern Maryland in 1972, a wide range of susceptibility to air pollution among the entries was observed. Catterton and Md.59 were found to be the most susceptible cultivars in the study with Wilson being the most tolerant. Hybrids with either Md.59 or Catterton as one of the parents and the other parent expressing a moderate to low tolerance to air pollution, normally had substantial damage from air pollution.

Significant correlations were observed between weather fleck damage ratings and agronomic, chemical and physical properties of the cured tobacco. Significant negative relationships were observed at one or more locations between air pollution damage and yields, price and value. Total alkaloid levels in composite samples were found to be negatively associated

with air pollution damage at one location; however, total nitrogen contents were not observed as being associated with weather fleck. Filling capacity and burning quality were both observed to be positively associated with air pollution damage at single locations.

References

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Table 1. Mean performance of Maryland tobacco cultivars and hybrids for certain agronomic and chemical characteristics averaged over three locations, 1972.

Cultivar or Hybrid	Weather fleck (15-75)	Yield lbs/A	Price $/cwt	Value $/A	Total Alk. (%)	Total N. (%)	Filling capacity cm^3/g	Burn Duration Sec.
Catterton	32.4	1248	76.67	959	1.85	2.49	7.92	16.6
Wilson	20.7	1474	76.87	1101	1.41	2.41	7.96	20.2
Gertz	26.3	1296	75.92	986	2.01	2.21	7.57	17.7
Md59	32.2	1349	77.74	1049	2.08	2.83	7.92	18.5
Md609	26.4	1290	79.03	1020	1.43	2.63	8.22	19.9
Md64	25.4	1660	74.90	1245	1.68	2.65	7.78	14.0
Md10	27.2	1243	76.79	955	1.85	2.36	7.69	15.0
Moore	26.1	1335	74.62	997	1.86	2.37	8.11	14.5
Cat x Wilson	25.5	1557	77.23	1204	1.71	2.56	7.80	16.6
Cat x Gertz	30.4	1286	76.30	984	1.92	2.11	7.80	18.6
Cat x Md59	35.1	1244	76.46	955	1.80	2.60	7.98	18.0
Cat x Md609	30.0	1366	77.09	1062	1.57	2.37	8.19	18.3
Cat x Md64	28.6	1492	76.76	1147	1.60	2.41	7.89	16.3
Cat x Md10	31.2	1231	76.32	952	1.49	2.22	7.95	18.9
Cat x Moore	25.4	1365	76.86	1053	2.01	2.31	7.88	17.1
Wil x Gertz	24.7	1349	75.19	1017	1.83	2.41	7.74	16.1
Wil x Md59	28.8	1343	76.68	1032	1.70	2.49	7.87	15.6
Wil x Md609	25.0	1640	79.07	1299	1.84	2.44	7.91	16.6
Wil x Md64	23.2	1602	75.97	1221	1.43	2.32	7.48	16.7
Wil x Md10	27.3	1449	75.83	1105	1.57	2.35	7.79	20.0
Wil x Moore	25.5	1304	76.65	1040	1.69	2.24	7.97	15.0
Gertz x Md59	29.6	1298	77.57	1009	1.88	2.47	7.69	19.2
Gertz x Md609	27.3	1411	78.27	1107	1.74	2.38	7.86	18.8
Gertz x Md64	24.6	1476	76.37	1129	1.80	2.55	7.88	18.0
Gertz x Md10	26.4	1397	77.66	1086	1.90	2.49	7.73	17.7
Gertz x Moore	23.8	1403	76.36	1072	2.08	2.34	7.77	16.2
Md59 x Md609	31.2	1469	79.44	1170	1.70	2.68	7.97	19.0
Md59 x Md64	28.9	1525	77.16	1180	1.91	2.53	7.68	18.3
Md59 x Md10	33.2	1275	77.56	989	1.82	2.53	7.74	19.6
Md59 x Moore	30.7	1450	76.91	966	1.87	2.47	7.98	15.9
Md609 x Md64	29.7	1610	78.59	1269	1.57	2.51	7.93	17.0
Md609 x Md10	29.7	1486	77.34	1156	1.80	2.66	7.90	18.6
Md609 x Moore	27.8	1389	78.34	1095	2.15	2.25	7.97	15.2
Md64 x Md10	29.7	1502	75.78	1145	1.48	2.28	8.07	17.2
Md64 x Moore	25.3	1517	76.08	1158	1.62	2.30	7.72	16.1
Md10 x Moore	27.3	1290	76.98	985	1.69	2.21	7.98	15.5
Mean	27.8	1401	76.93	1080	1.76	2.43	7.87	17.3
L.S.D. (0.05)	4.4	171	1.71	152	0.37	0.28	N.S.	N.S.
(0.01)	5.8	227	2.27	202	0.49	0.37	N.S.	N.S.

Table 2. Phenotypic correlations of weather fleck with agronomic and chemical characteristics at three locations, 1972.

Character	Location		
	Upper Marlboro	Davidsonville	Dentsville
Yield (lbs/A)	-0.17	-0.18	-0.48**
Price ($/100 lbs)	-0.24*	-0.26**	-0.24*
Value ($/A)	-0.14	-0.18	-0.48**
Total Alkaloids (%)	-0.02	-0.24*	-0.12
Total Nitrogen (%)	0.04	0.16	-0.04
Filling Capacity (cm^3/g)	0.32**	0.14	0.16
Burn Duration (Sec)	0.08	0.12	0.26**

* - Significant at 5% level of probability.

** - Significant at 1% level of probability.

Correlation of Air Pollution Susceptibility of Maryland Tobacco Cultivars and Hybrids with Physical Characteristics of the Plant

Rosanna Hsieh, C. L. Mulchi and M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

Studies involving factors which contribute to susceptibility among plants to air pollution have generally been restricted to chemical and morphological factors associated with leaves, especially during leaf maturation. Limited information has been published involving air pollution susceptibility and such factors as plant shape, an important factor in a tobacco breeding program along with agronomic information such as yields, price and value of the cured product. Information on the relationships between the physical characteristics of plants and air pollution susceptibility would be of value in a breeding program designed to develop cultivars with improved tolerance to air pollution.

Procedures

In the study by Hsieh, et al., reported in the preceding paper in this volume, the opportunity was provided to investigate the relationships between physical characteristics of field-grown Maryland tobacco plants and their sensitivity to air pollution. The study involved 36 Maryland tobacco cultivars and hybrids at three locations in southern Maryland during 1972. Refer to the preceding report for details on locations, Maryland tobacco entries, cultural practices, procedures for scoring air pollution damage and information on experiment design. The physical characteristics of interest include days to flower or plant maturity, plant height, number of leaves per plant and the internode lengths for each entry.

During the summer, flowering data were collected during the flowering period at approximately three-day intervals. At each day of collection,

all inflorescences with at least one open flower were counted and the total for a given day was recorded. After all the plants in a plot had flowered, the data were plotted on a graph and the average number of days required for 50 percent of the plants in the plot to produce at least one open flower from the day of transplanting was determined from the graph.

Plant height at maturity was determined for each plot during the stripping operation by measuring the lengths of 10 stalks from each plot and the average stalk length in centimeters was recorded.

The number of leaves per plant for each entry was determined by counting the number of leaf scars per stalk referred to above and the average number of leaves per plant recorded.

The internode lengths for each entry was determined by dividing the plant heights at maturity by the number of leaves per plant.

Results

A summary of means for weather fleck ratings, plant height at maturity, leaves per plant, internode lengths and days to flower for each of the 36 entries averaged over three locations are shown in Table 1. Significant differences were found among both cultivars and hybrids for weather fleck ratings, leaves per plant and internode lengths; among hybrids for plant height; and among cultivars for days to flower in a combined analysis over locations.

Phenotypic correlations of weather fleck ratings with each of the physical characteristics of interest for the three locations are shown in Table 2. There were significant positive relationships noted at two locations between weather fleck ratings and plant height, indicating that taller plants appear more susceptible to air pollution damage than shorter plants. Also, there were significant positive relationships observed at two locations between weather fleck and internode lengths suggesting that

plants with more open-type canopy structures are more subject to air pollution damage than plants with more compact structures. However, there were no significant relationships found between the number of leaves per plant and susceptibility to air pollution damage. The positive relationships found between plant height and internode lengths and weather fleck ratings indicate that breeding programs to develop cultivars with greater tolerance to air pollution should give preference to shorter, more compact plants during selection.

The positive relationships between air pollution susceptibility and plant heights and internode lengths are most probably related to increased air flow through the plant canopy. The more compact structures would reduce the flow of polluted air through the canopy. Observations have been made that shaded leaves tend to show less damage from air pollution. The shading effects are perhaps related to a number of physiological factors involving light such as plant growth regulators, carbohydrate levels and nitrogen metabolic activities. These physiological factors have all been associated with regulating air pollution susceptibility.

The relationships between flowering data and weather fleck in this study were not conclusive. Plants at Davidsonville showed a significant positive relationship with air pollution damage; however, plants at Upper Marlboro and Dentsville indicated negative trends for days to flowering and air pollution susceptibility. These mixed results can most probably be attributed to variations in the timing of the pollution stagnation periods in relation to the development of the plants at the three locations. A close association has been demonstrated between physiological maturity of the leaves and air pollution susceptibility. Therefore, the timing of air stagnation periods in relation to plant maturity would be critical. Should the periods of high air pollution coincide with the period when a large

percentage of the plant leaves was reaching physiological maturity, a high probability for pollution damage would result.

Another point of consideration regarding plant maturity vs. air pollution susceptibility concerns the timing of plant harvest following its maturation. Cultivars which are subject to air pollution damage which remain in the field beyond their normal harvest date would be subject to increased air pollution damage. Since air pollution damage on tobacco is normally progressive from the bottom of the plant upward, delayed harvest would bring more leaves into the critical period for air pollution damage. These factors could contribute to mixed results regarding air pollution damage vs. days to flower, in studies such as these where multiple maturity dates were present, yet single harvest dates were employed.

Summary

Significant differences were observed among 36 cultivars and hybrids of Maryland tobacco for air pollution damage, plant heights, leaves per plant and internode lengths, but not for days to flower, in a combined analysis over three locations in 1972.

Phenotypic correlations of weather fleck ratings with physical characteristics of the field-grown tobacco plants showed significant positive relationships between both plant height and internode lengths at two of the three locations but relationships with number of leaves per plant were nonsignificant. These results support the suggestion that in a breeding program to develop cultivars tolerant to air pollution, considerations should be given for shorter, more compact plant structures during selection.

Correlations between days to flower and weather fleck damage appeared inconclusive. The mixed results were attributed to variations in the timing of the high air pollution periods and plant development at the various locations.

Table 1. Mean performance of Maryland tobacco cultivars and hybrids for certain physical plant characteristics averaged over three locations. 1972.

Cultivar or Hybrid	Weather fleck (15-75)	Plant height (cm)	Leaves per Plant	Internode length (cm)	Days to flower
Catterton	32.4	71.5	19.4	3.69	63.4
Wilson	20.7	73.2	18.3	3.99	59.1
Gertz	26.3	73.2	18.3	4.00	60.4
Md59	32.2	77.2	17.9	4.31	64.9
Md609	26.4	78.1	18.6	4.16	66.4
Md64	25.4	72.9	20.4	3.50	63.6
Md10	27.2	75.0	19.1	3.91	62.0
Moore	26.1	68.4	18.5	3.70	60.8
Cat x Wilson	25.5	75.0	19.2	3.91	59.9
Cat x Gertz	30.4	74.7	18.5	4.06	60.8
Cat x Md59	35.1	79.6	19.2	4.15	60.6
Cat x Md609	30.0	73.9	18.7	3.92	63.1
Cat x Md64	28.6	73.4	19.5	3.76	64.8
Cat x Md10	31.2	75.5	19.5	3.98	61.8
Cat x Moore	25.4	69.5	18.9	3.64	62.2
Wil x Gertz	24.7	73.9	18.0	4.12	61.9
Wil x Md59	28.8	72.4	17.9	4.04	61.6
Wil x Md609	25.0	80.2	18.6	4.31	60.6
Wil x Md64	23.2	71.2	19.4	3.69	64.1
Wil x Md10	27.3	71.7	19.1	3.73	61.1
Wil x Moore	25.5	69.7	17.9	3.92	58.6
Gertz x Md59	29.6	75.5	18.3	4.12	60.6
Gertz x Md609	27.3	78.5	18.9	4.16	60.8
Gertz x Md64	24.6	72.0	19.2	3.75	66.4
Gertz x Md10	26.4	78.1	18.8	4.17	60.2
Gertz x Moore	23.8	73.4	18.5	3.99	60.1
Md59 x Md609	31.2	82.2	18.1	4.57	63.8
Md59 x Md64	28.9	76.5	19.6	3.91	64.2
Md59 x Md10	33.1	80.2	19.0	4.22	61.9
Md59 x Moore	30.7	74.5	17.9	4.15	60.8
Md609 x Md64	29.6	76.2	20.0	3.78	63.2
Md609 x Md10	29.7	81.9	20.3	4.05	60.1
Md609 x Moore	27.8	75.5	18.8	4.01	60.6
Md64 x Md10	29.7	77.0	20.2	3.81	64.0
Md64 x Moore	25.3	72.3	19.3	3.75	63.6
Md10 x Moore	27.3	72.8	19.0	3.86	60.7
Mean	27.8	74.9	18.9	3.97	62.7
L.S.D. (0.05)	4.4	6.7	1.4	0.30	N.S.
(0.01)	5.8	8.9	1.8	0.40	N.S.

Table 2. Phenotypic correlations of weather fleck ratings with physical characteristics of the 36 entries at three locations. 1972.

Character	Location		
	Upper Marlboro	Davidsonville	Dentsville
Plant height	0.28**	0.27*	0.02
Leaves per plant	0.08	0.08	-0.08
Internode length	0.23*	0.27*	0.15
Days to flower	-0.11	0.21*	-0.16

* - Significant at 5% level of probability

** - Significant at 1% level of probability

Correlation of Air Pollution Damage with Certain Chemical Components in Freeze-Dried Green-Leaf Tissue from Maryland Tobacco Cultivars and Hybrids

Rosanna Hsieh, C. L. Mulchi and M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

Previous studies have shown that multiple factors both physiological and morphological in nature are associated with mechanisms regulating the tolerance of plant leaves to air pollution. Among the physiological factors which have been investigated with tobacco include nitrogen and carbohydrate metabolic activities. Since both of these processes are associated with alkaloid and polyphenol synthesis and accumulation in plants, it was of interest to examine the relationships between these four chemical components in Maryland tobacco and air pollution susceptibility.

Procedures

Green leaf samples were collected from plants included in the study by Hsieh, et al., discussed in the preceding papers in this volume. Refer to the preceding reports for details on experiment locations, tobacco entries, cultural practices, methods for scoring air pollution damage and experiment design.

In mid-August, fresh leaf samples were taken from each plot. A sample consisted of 10 half-leaves and was obtained for the lower (about the fourth leaf from the base of the plant), middle (about the eighth leaf), and upper (about the twelth leaf) stalk positions. No samples were collected from the upper stalk positions at Davidsonville and Dentsville. The major interest was in the levels of these compounds in leaves, either within or approaching the critical stages of leaf development where air pollution susceptibility was highest. The fresh leaf samples were

immediately placed on dry ice to stop their metabolic activity, then later transferred while still in a frozen state to a freeze-drier. Upon drying, the samples were ground in a Wiley Mill through a 40-mesh screen and sealed in glass containers.

The freeze-dried samples were analyzed in the Tobacco Chemistry Laboratory for total alkaloids, employing methods developed by Griffith (1957); total nitrogen contents using micro-Kjeldahl procedures described by Gains (1971); total carbohydrates, by methods proposed by Scott and Melvin (1953); and total polyphenols, by procedures developed by Anderson and Todd (1968), employing chlorogenic acid as a standard.

For establishing the level of air pollution damage to leaves within a stalk position, the leave scores were grouped into three groups. The totals for leaves 1 to 5, 6 to 10 and 11 to 15, represented the lower, middle and upper stalk positions, respectively. Using the totals to indicate relative damage within a stalk position, the range for damage within a stalk position ranged from 5 to 25, with 5 representing no damage and 25, indicating severe damage. (Refer to preceding reports for details on scoring.)

Results

Significant differences were found among the 36 cultivars and hybrids and stalk positions for each of the four chemical components. Total nitrogen and total alkaloid levels were determined for all samples collected; however, total carbohydrate and total plant phenols were only determined on the lower and middle stalk position samples from Upper Marlboro. The data in Table 1 summarize the relationships among stalk positions for weather fleck and all four chemical components in samples from Upper Marlboro. Since no major differences were found between means for cultivars vs. hybrids, data from all entries were included for determining the stalk

position means. These results indicate that air pollution damage, total alkaloids and total polyphenols content decreases with an increase in stalk position. Total nitrogen and total carbohydrate levels appear to increase with an increase in stalk position.

The higher levels of air pollution damage in the lower and middle stalk positions can be attributed to the more advanced stages of physiological maturity for leaves at these positions. Leaves reach a peak in sensitivity to air pollution as the tissue attains physiological maturity or when they reach 75 to 95% of their maximum elongation. Total alkaloid levels also correlate with physiological maturity of leaves. Alkaloids accumulate in leaves with time, thus older leaves would have higher levels than younger leaves. Older leaves also tend to have lower soluble carbohydrate levels and higher phenol contents.

Phenotypic correlations of air pollution damage at the middle and lower stalk positions with levels of the four chemical components of interest are shown in Table 2 for the Upper Marlboro location. For the lower stalk position, significantly positive relationships were found between air pollution damage and total carbohydrates and total nitrogen contents. All correlations for the middle stalk position were nonsignificant. Nonsignificant negative relationships were noted for total alkaloids at both stalk positions and nonsignificant positive relationships were noted for total polyphenols at both stalk positions. In general, these results do not fully agree with findings by previous authors and tend to discount their importance as major regulatory factors.

However, as shown in Table 3, when phenotypic correlations were performed by combining data over a wider range of physiological maturity than existed within a given stalk position, highly significant relationships between each of the chemical components and air pollution sensitivity were

produced. Since each of these chemical factors have been shown to be influenced by physiological maturity (Table 1), the highly significant relationships shown in Table 3 may be attributed more to a coincidence rather than to actual cause and effect relationships. In order to establish cause and effect relationships, one should compare data within a maturity range or in Table 2.

Summary

Green leaf samples were obtained from two and three stalk positions from 36 Maryland cultivars and hybrids at three locations. After freeze-drying, the samples were analyzed for total nitrogen, total alkaloids, total carbohydrates and total polyphenols. The tissue was found to have increasing levels of total nitrogen and total carbohydrates and decreasing levels of total alkaloids and total polyphenols with an increase in stalk position or a decrease in physiological maturity of the tissue. Higher levels of air pollution damage were found on the older, more mature leaves in the middle and lower stalk positions.

Significant positive relationships were found between total carbohydrate and total nitrogen levels and air pollution damage at the lower stalk position. All other correlations at other stalk positions were non-significant. Very slight negative trends for total alkaloids and very slight positive trends for polyphenols were noted for correlations with weather fleck damage at the middle and lower stalk positions.

Table 1. Mean performance of eight Maryland tobacco cultivars and 28 F_1 hybrids for weather fleck ratings, total nitrogen, total alkaloid, total carbohydrate, and total polyphenol content in freeze-dried green tissue at three stalk positions at Upper Marlboro, Md. 1972.

Stalk position	Weather fleck (5-25)	Total nitrogen (%)	Total alkaloids (%)	Total carbo hydrate (%)	Total poly-phenols
Upper	5.56	5.34	0.87	----	----
Middle	10.05	4.52	1.42	5.22	2.14
Lower	13.95	2.68	1.97	3.85	3.03

Table 2. Phenotypic correlation of weather fleck with four chemical constituents in freeze-dried green tissue for middle and lower stalk position at Upper Marlboro. (df = 108)

Chemical constituents	Stalk position	
	Lower	Middle
Total carbohydrates	0.2214*	0.1368
Total nitrogen	0.2417*	0.0150
Total alkaloids	-0.0663	-0.0394
Total polyphenols	0.0472	0.0630

* Significant at the 5% level.

Table 3. Phenotypic correlations of weather fleck ratings with total nitrogen, total alkaloids, total carbohydrate, and total polyphenol contents in freeze-dried green tissue of Maryland tobacco cultivars and hybrids combined over stalk positions at three locations, 1972.

Chemical constitutents	Location		
	Upper Marlboro	Davidsonville	Dentsville
Total nitrogen	-0.5307**	-0.5404**	-0.7626**
Total alkaloids	0.3432**	0.3854**	0.5862**
Total carbohydrates	-0.2402**	---	---
Total phenols	0.3515**	---	---

** Significance at 1% level of probability.

Survey of Total Nitrogen, Total Alkaloids and Total Chloride Contents in Maryland Tobacco from 1971, 1972 and 1973 Crops

C. L. Mulchi and C. G. McKee
Department of Agronomy

Purpose and Objectives

In recent years, there has been increased interest in the chemical quality of Maryland tobacco, especially in the total alkaloid contents of the cured tobacco. The tobacco industry in general has expressed greater interest in the chemical quality of tobacco due to increased public awareness of health problems which have been associated with the smoking of tobacco products. Thus, it became necessary to survey the chemical quality of the tobacco produced each year to gain information on changes which may be occurring as a result of changes in production practices and changes due to natural variables such as weather conditions during the growing seasons.

Procedures

In 1967, a sampling program was initiated by which county extension agents in the five major tobacco producing counties in southern Maryland — i.e. Prince George's, Charles, Calvert, Anne Arundel and St. Mary's — would visit selected farms during the fall and winter months and obtain samples from the "bright" grades of tobacco. The bright grades appear at the center of the stalk and represents the best quality tobacco. The samples were labeled as to their county locations and forwarded to the Tobacco Chemistry Laboratory for chemical analysis.

The results in this report summarize results from the 1971, 1972 and 1973 crops. The number of samples for each crop year were 71, 67 and 81 samples for 1971, 1972 and 1973, respectively.

The samples were dried in a forced air oven at 70° C, ground in a Wiley mill through a 1 mm screen, and stored in glass containers. The samples were analyzed for total nitrogen employing micro-Kjeldahl procedures described by Gains (1971), total alkaloids by procedures developed by Griffith (1957), and total chlorides by procedures reported by Gains (1971).

Results

The results in Table 1 summarize the means for total nitrogen, total alkaloids and total chloride contents for all samples collected over the three-year reporting period and averages for a seven-year period for total nitrogen and total alkaloids. Total nitrogen levels in the cured tobacco for 1971 and 1973 averaged 13.0 and 18.1%, respectively, above the seven-year average of 2.53%. Total alkaloid levels for 1971 and 1972 averaged 20.6 and 12.4%, respectively, below the seven-year average of 2.18%. However, total alkaloid levels in 1973 were 29.8% above the seven-year average. The high alkaloid levels in 1973 were particularly alarming to certain tobacco companies which traditionally have shown substantial interest in the quality of Maryland tobacco.

The total chloride contents in Maryland tobacco have shown much less variation over the past three years than total nitrogen and total alkaloids. Since fertilizers for use on Maryland tobacco must contain only small quantities of chloride, one would not anticipate large variations in the average chloride contents from one year to the next.

The information showm in Table 2 illustrates the relative distribution of the total nitrogen, total alkaloids and total chloride contents in the cured samples from the three-year reporting period. In 1971, approximately 79% of the samples were within the range of 2.5 to 4.0% nitrogen. The total

nitrogen data for 1972 illustrates a more normal distribution with only 45% of the samples in the range of 2.5 to 4.0% nitrogen. However, in 1973, approximately 76% of the samples were above 2.5% nitrogen. These trends suggest that nitrogen levels over the past three years were somewhat elevated. The causes for these higher levels are somewhat obscure. There have been some speculation that farmers are using higher rates of nitrogen fertilization than current recommendations in an effort to increase yields. An effort will be made during the current growing season to gain information on current fertilization programs being employed by Maryland tobacco growers.

The alkaloid levels in the 1971 and 1972 samples had about the same general distribution — i.e. from 56 to 70% of the samples, respectively, below 2.0% alkaloids. In 1973, approximately 90% of the samples exceeded 2.0%. Certainly 1973 was not a typical year with regards to alkaloids. The high alkaloid levels for the 1973 samples could result from several factors including nitrogen fertilization, varieties, the increased use of maleic hydrazide for sucker control and dry weather. All of these factors are important and the combination of several of these factors could induce higher alkaloid levels. The program being planned for the 1974 crop should give suggestions as to which of these factors are the dominant causes for higher alakloids in Maryland tobacco in recent years.

The distribution data for chloride indicates that approximately 70% of the samples contain less than 0.3% chloride. These low chloride levels are an important factor in the good burning qualities and high filling capacities exhibited by Maryland tobacco.

Summary

Tobacco samples from the five major tobacco producing counties in Maryland for the 1971, 1972 and 1973 crops were examined for total nitrogen, total alkaloids and total chloride levels in the cured tissue. Substantially higher total nitrogen levels than the seven-year average of 2.53% nitrogen were noted for the 1971 and 1973 samples. The total alkaloid levels in 1973 exceeded the seven-year average of 2.18% alkaloids by 29.8%. Chloride levels appear to average 0.23% in the samples and remained relatively stable over the three years reporting period.

A program designed to identify the major causes for the increasing levels of total nitrogen and total alkaloids in Maryland tobacco is being planned for the 1974 crop.

References

Gains, T. P. 1971. Chemical Methods of Tobacco Plant Analysis. Res. Sta. Rept. 97. College of Agri. Expt. Stations, Tifton, Ga.

Griffith, R. B. 1957. The rapid determination of total alkaloids by steam distillation. Tobacco Sci. 1: 130-137.

Table 1. Mean total nitrogen, alkaloids and chloride contents of Maryland tobacco samples for 1971, 1972 and 1973 crops.

Crop Year	Total Nitrogen %	Total Alkaloids %	Total Chloride %
1971	2.87	1.73	0.20
1972	2.54	1.91	0.23
1973	2.95	2.83	0.27
1967-1973	2.53	2.18	0.23 a/

a/ Mean for 1971, 1972 and 1973 crops, only.

Table 2. Relative distribution of total nitrogen, alkaloids and chloride contents of tobacco samples[a/] collected from Maryland farms in 1971, 1972 and 1973.

Total Nitrogen				Total Alkaloids				Total Chloride			
Leaf Contents %	Sample Distribution (%) 1971	1972	1973	Leaf Contents %	Sample Distribution (%) 1971	1972	1973	Leaf Contents %	Sample Distribution (%) 1971	1972	1973
< 1.5	0	2.9	0	< 0.5	0	0	0	< 0.15	45.1	35.8	41.9
1.5-2.0	2.1	16.7	7.6	0.5-1.0	8.3	7.6	1.2	0.15-0.30	38.0	34.3	29.7
2.0-2.5	18.7	34.8	16.4	1.0-1.5	37.5	22.7	3.8	0.31-0.45	11.3	19.4	11.1
2.5-3.0	33.4	22.8	39.3	1.5-2.0	25.0	25.8	5.1	0.46-0.60	4.2	1.5	4.9
3.0-3.5	37.5	16.7	16.5	2.0-2.5	14.6	24.2	22.7	0.61-0.75	0	6.0	4.9
3.5-4.0	8.3	6.1	12.6	2.5-3.0	6.3	15.2	27.9	0.76-0.90	0	1.5	4.9
> 4.0	0	0	7.6	3.0-3.5	8.3	4.5	27.9	> 0.91	1.4	1.5	2.5
				> 3.5	0	0	11.4				
	100.0	100.0	100.0		100.0	100.0	100.0		100.0	100.0	100.0

[a/] Sample totals for 1971, 1972 and 1973 equaled 71, 67 and 81, respectively.

Long Season N.E. Diallel Single Cross Corn Variety Test

Joseph L. Newcomer
Department of Agronomy

Purpose and Objectives

The purpose of the project is to evaluate for performance and suitability for production of grain and silage inbred lines and single crosses made by corn breeders at Experiment Stations in the Northeast.

Procedures

The tests were located on the Plant Research Farm at Fairland, Maryland. The plots were planted by hand in a uniform design and each plot design was duplicated at all cooperating states so that uniform statistical analysis could be made. The plot size was a single row 25 feet long in 30 inch wide rows replicated 7 times. Notes were taken during the growing season on tasseling and silking dates, tassel color, silk color, ear height, plant height, diseases, stalk breakage, root lodging, bird damage, yield, moisture and other characteristics. The raw data were summarized and sent to Pennsylvania for statistical analysis.

Results

The results are valuable in determing lines and crosses to be eliminated from further testing. A corn breeder can use this information to better determine the suitability of inbred lines and single crosses for the entire Northeast Region.

A similar test is planned for 1974.

Herbicides for Conventionally Planted Corn

J. V. Parochetti
Department of Agronomy

Purpose

Annual weed control in conventionally planted corn is achieved primarily by good seed bed preparation and application of preemergence and postemergence herbicides. More than 80% of Maryland corn growers use herbicides in corn production. Four field experiments were conducted to evaluate several new, unregistered, and recently registered, herbicides in comparison with recommended herbicides. Parameters observed and measured were control of specific weeds, effect on the corn, and the yield of corn.

Procedure

The four field experiments were established at the Wye Institute, on May 2, 1973, on a Mattapex silt loam. The corn variety planted was 'XL-43'. Preplant incorporated herbicides were incorporated 3 to 4 inches deep with a tractor mounted rototiller on May 1; preemergence herbicides were applied May 2.

Early postemergence herbicides were applied May 22 when corn was in the 3 leaf stage and the 4th leaves were in the roll; grassy weeds were 0.25 inches tall, and broadleaved weeds were 1 inch tall with common lambsquarters being in the 3 leaf stage. Late postemergence was applied June 5, when corn was in the 7 leaf stage and grassy weeds were in the 5 leaf stage (3 inches tall) and velvetleaf, redroot pigweed and jimsonweed being about 2 inches tall.

The experimental design was a randomized complete block with 4 replications. Plot size was 10 by 30 feet. Herbicides were applied at 30 gpa. The soil was Mattapex silt loam.

The following parameters were observed and recorded: control of weeds by species, the effect on corn, and yield of corn. Weed control and corn injury were visually rated using the European rating system; corresponding percentages are listed in Table 1.

Table 1. European system for evaluating weed and crop responses utilized in these investigations.

Rating Number	Effect on Crop	% Crop injury	% Weed Control	Remarks
1	No injury	0	100.0	Completely Destroyed
2	May be injured	2.5	97.5	Very good control
3	A little injured	5.0	95.0	Good control
4	Injured, but satisfactory	10.0	90.0	Satisfactory
5	Injured, barely satisfactory	15.0	85.0	Just satisfactory
6	Not satisfactory	25.0	75.0	Unsatisfactory
7	Bad injury	32.5	65.0	Poor
8	Very bad injury	65.0	32.5	Very poor
9	100% destroyed	100.0	0	As untreated

Results

Experiment 1 was conducted to evaluate several experimental herbicides alone and in combination with registered herbicides (Table 2).

Most herbicide combinations were highly affective against giant green foxtail except cyprazine + ethiolate (sold as Prefox) and cyprazine and alachlor; cyprazine at .75 lb/A also affected low foxtail control.

Velvetleaf control was best with combinations of cyprazine + butylate and atrazine + butylate; also effective were atrazine + alachlor, cyanazine + butylate, and atrazine. Exceptionally poor control of velvetleaf resulted with both rates of alachlor.

All herbicides and combinations were effective for lambsquarter control, except alachlor, 1.5 lb/A, butylate, 3 lb/A, and cyprazine + alachlor.

For smartweed control, most herbicides were effective except butylate, alachlor (1.5 lb/A) and cyprazine + alachlor.

Best yellow nutsedge control resulted with butylate combinations. Poorest nutsedge control resulted with the low rates of triazine herbicides (cyprazine, atrazine, cyanazine, and simazine).

All corn yields from herbicide treatments were significantly higher than the uncultivated check, but similar to the cultivated check.

Experiment II was conducted to evaluate two experimental Niagara Chemical Company herbicides, three formulations of cyanazine versus atrazine (Table 3).

Cyanazine, 80 WDL and 80W + Sun Oil applied to corn in the 6 leave stage caused extensive corn injury and vigor reduction; this injury persisted as evidenced by the reduced corn height on 7/5/73. The addition of Sun Oil 11E was not phytotoxic when applied to corn in the 4 leave stage. All other applications including NIA 29615 and NIA 29616 did not injure corn.

Even though corn was injured, corn yields were not significantly different.

In tests in 1971 and 1972, late postemergence applications of cyanazine, especially with oil, caused excessive corn injury. These data clearly point out the importance of preemergence or early postemergence applications of cyanazine to avoid corn injury.

Experiment III was conducted to evaluate cyanazine, alachlor; dicamba and atrazine as preemergence and postemergence treatments alone and in combination. (Table 4)

Greatest corn vigor reduction occurred when dicamba was applied preemergence followed by postemergence dicamba (treatment 11). Treatment 11 also caused a significant reduction in corn stand. All treatments containing

dicamba caused corn vigor reduction but not as severe as treatment 11. Giant green foxtail control ratings were 2.75 or higher for all treatments except dicamba preemergence which resulted in 5.5 rating. Postemergence dicamba failed to control foxtail. Velvetleaf control was erratic with many of the herbicides except dicamba alone or in combination as preemergence or postemergence treatments. Lambsquarter control was excellent with all herbicides except alachlor at 2 lb/A. Lowest corn yields were with the uncultivated control; highest corn yields were with the cultivated control.

Experiment IV was conducted to compare cyprazine and atrazine as preemergence and postemergence herbicides (Table 5).

Except for cyprazine (4 lb/gal. formulation + 1 gal/A 11E oil) none of the treatments significantly reduced corn vigor. All herbicides affected high ratings for foxtail control. Fall panicum control was variable; preemergence and late postemergence cyprazine affect poor control. Only one treatment, early postemergence cyprazine (1 lb/gal. formulation) at 1.5 lb/A, affect excellent control of fall panicum. Excellent control of common lambsquarters and redroot pigweed resulted from all treatments.

All corn yields resulting from the herbicide treatments were significantly higher than the uncultivated control.

Summary

Of the combinations of herbicides tested the following affected adequate to excellent grassy weed control: atrazine + butylate, cyanazine + butylate, cyanazine + alachlor, alachlor + atrazine, and alachlor + simazine. Butylate combinations were most effective for yellow nutsedge control.

Of the postemergence herbicides, dicamba caused corn injury; when dicamba was applied as a preemergence treatment alone or in combination

corn was injured slightly, but excessive corn injury occurred if dicamba was applied postemergence following a preemergence application of dicamba.

Cyanazine, cyprazine and atrazine were compared. Of these three triazines, cyanazine caused greatest corn injury especially late postemergence; cyanazine plus oil caused excessive corn injury. At the rates studied, cyprazine and atrazine caused little corn damage and affected similar weed control.

Table 2. Experiment I The effect of herbicides and combinations for annual weed control in corn

	Treatment	Rate (lb/A)	Time of Application	June 25 Giant Green Foxtail (Rating[a])	(%)[b]	June 25 Velvetleaf (Rating[a])	(%)[b]	June 25 Common Lambsquarters (Rating[a])	(%)[b]	June 25 Pa. Smartweed (Rating[a])	(%)[b]	June 25 Yellow Nutsedge (Rating[a])	(%)[b]	September 11 Corn Yield (Bu/A)
1.	Control	-	-	9.0	0	9.0	0	9.0	0	9.0	0	9.0	0	74.1
2.	Control Cultivated	-	-	2.25	97	2.0	97.5	2.5	96	1.75	98	2.75	96	146.4
3.	Cyprazine (Outfox)	.75	ppi	1.25	99	1.5	98.5	1.0	100	1.0	100	1.5	98.5	145.2
4.	Cyprazine (Outfox) + Butylate (Sutan)	.75 + 3.0	ppi	1.5	98.5	1.5	98.5	1.0	100	1.0	100	1.5	98.5	145.2
5.	Atrazine (AAtrex) + Butylate (Sutan)	1.0 + 3.0	ppi	1.0	100	1.75	98	1.0	100	1.25	99	1.5	98.5	134.2
6.	Atrazine (AAtrex)	1.2 + 2.0	pre	1.25	99	3.0	95	1.0	100	1.0	100	3.0	95	158.9
7.	Cyprazine (Prefox) + Ethiolate	.56 + 3.0	ppi	5.25	82.5	6.75	72.5	2.75	96	1.0	100	4.5	87.5	109.9
8.	Cyprazine (Prefox) + Ethiolate	.75 + 4.0	ppi	6.75	72.5	4.75	86	1.0	100	2.5	98	5.0	85	132.6
9.	Cyprazine (Outfox) + Alachlor (Lasso)	.75 + 1.5	pre	3.0	95	4.5	87.5	3.0	95	3.0	95	4.0	90	120.9
10.	Cyanazine (Bladex) + Butylate (Sutan)	1.0 + 3.0	ppi	2.0	97.5	2.25	97	1.0	100	1.0	100	2.5	96	139.9
11.	Cyanazine (Blade) + Alachlor (Lasso)	1.0 + 1.5	pre	2.0	97.5	5.25	82.5	1.0	100	1.0	100	3.75	91	138.3
12.	Butylate (Sutan)	3.0	ppi	1.0	100	3.75	91	5.75	77.5	4.0	90	2.50	96	120.5
13.	Cyprazine (Outfox)	.75	pre	5.0	85	5.75	77.5	1.0	100	1.25	99	5.5	80	140.6
14.	Atrazine (AAtrex)	1.0	pre	2.75	96	2.50	96	1.0	100	1.0	100	4.75	86	140.6
15.	Cyanazine (Bladex)	1.5		2.75	96	5.25	82.5	1.0	100	1.0	100	5.25	82.5	137.7
16.	Cyanazine (Bladex)	1.0		2.25	97	4.50	87.5	1.0	100	1.5	98.5	5.75	77.5	136.8
17.	Simazine (Princep)	1.0	pre	2.0	97.5	5.50	80	1.0	100	1.25	99	4.50	87.5	138.6
18.	Alachlor (Lasso)	2.0	pre	1.25	99	8.50	13	2.75	96	1.5	98.5	3.0	95	117.7
19.	Alachlor (Lasso)	1.5	pre	1.25	99	8.0	32	3.25	94	2.0	97.5	2.5	96	116.2
20.	Alachlor (Lasso) + atrazine	1.5 + 1.0	pre	1.0	100	3.0	95	1.0	100	1.0	100	3.75	91	148.6
21.	Alachlor (Lasso) + cyanazine	2.0 + 1.5	pre	1.0	100	3.5	92.5	1.0	100	1.0	100	3.25	94	128.4
22.	Alachlor (Lasso) + cyanazine	2.0 + 1.0	pre	1.25	99	2.75	96	1.0	100	1.0	100	3.5	92.5	130.4
23.	Alachlor (Lasso) + simazine	1.5 + 1.0	pre	1.75	98	5.5	80	1.0	100	1.5	98.5	3.75	91	122.6
		Bayes lsd 0.05		1.74		1.77		1.93		1.45		1.83		31.62

[a] European rating system: for weed control 1 = 100%, 2 = 97.5%, 3 = 95%, 4 = 90%, 5 = 85%, 6 = 75%, 7 = 65%, 8 = 32.5%, 9 = 0%

[b] The % is an approximation.

Table 3 Experiment II: The effect of preemergence and postemergence applications of cyanazine and atrazine on corn.

Treatment	Rate lb/A	Time of Application	June 11 Corn Mecrosis Rating[a]	June 11 Corn Mecrosis (%)[b]	June 25 Corn Vigor Reduction Rating[a]	June 25 Corn Vigor Reduction (%)[b]	July 5 Corn Height (Inches)	July 5 Corn Population A	September 11 Corn Yield (Bu/A)
1. Control	____	____	1.0	0	1.0	0	81.00	21339	128.1
2. Cyanazine (Bladex) 80W	2.0	pre	1.0	0	1.25	1	75.25	20564	150.0
3. Cyanazine (Bladex) WDL	2.0	pre	1.0	0	1.0	0	79.00	20253	151.9
4. Cyanazine (Bladex) 20G	2.0	pre	1.0	0	1.25	1	79.00	21650	147.2
5. Atrazine (AAtrex) 80W	2.0	pre	1.0	0	1.0	0	82.75	22038	160.9
6. Atrazine (AAtrex) WDL	2.0	pre	1.0	0	1.0	0	85.00	20952	151.6
7. Atrazine (AAtrex) WDL	2.0	early post	1.0	0	1.0	0	80.75	22271	153.8
8. Atrazine (AAtrex) 80W	2.0	early post	1.0	0	1.0	0	81.50	20564	144.5
9. Atrazine (AAtrex) 80W + Sun oil 11E	2.0	early post	1.0	0	1.5	1.5	79.50	22193	149.4
10. Cyanazine (Bladex) 80W	2.0	early post	1.0	0	1.0	0	78.50	20641	143.9
11. Cyanazine (Bladex) WDL	2.0	early post	1.0	0	1.0	0	80.50	21805	150.1
12. Cyanazine (Bladex) 20G	2.0	early post	1.0	0	1.0	0	77.75	21572	150.6
13. Cyanazine (Bladex) 80W + Sun oil 11E	2.0	early post	1.0	0	1.5	1.5	78.25	22426	105.4
14. Cyanazine (Bladex) WDL	2.0	late post	6.75	27.5	5.5	20.	66.75	20020	136.0
15. Cyanazine (Bladex) 80W	2.0	late post	1.0	0	1.5	1.5	79.00	21184	150.3
16. Cyanazine (Bladex) 15G	2.0	late post	1.0	0	1.75	2.	79.25	21262	122.1
17. Cyanazine (Bladex) 80W + Sun oil 11E	2.0	late post	7.75	59.	5.75	22.5	68.50	20408	133.3
18. Atrazine (AAtrex) 80W	2.0	late post	1.0	0	1.0	0	76.00	21417	149.7
19. Atrazine (AAtrex) WDL	2.0	late post	1.0	0	1.25	1	76.00	21650	151.7
20. NIA 29615	1.0	pre	1.0	0	1.25	1	83.75	22116	149.0
21. NIA 29615	1.5	pre	1.0	0	1.75	2.	75.25	19710	138.9
22. NIA 29616	1.0	pre	1.0	0	1.50	1.5	80.25	21805	152.4
23. NIA 29616	1.5	pre	1.0	0	1.25	1	76.50	21184	147.0
		Bayes lsd 0.05	.176		.635		8.61	N. S.	N. S.

[a] European rating system: 1 = 100% weed control; 5 = 85% weed control

[b] The % is an approximation.

Table 4 Experiment III: The effect of cyanazine, alachlor, dicamba and atrazine as preemergence and postemergence treatments alone and in combination for weed control in corn.

Treatment	lbA	Time of Application	June 11 Vigor Reduction Rating[a] (%)[b]	June 25 Redroot Pigweed Rating[a] (%)[b]	June 25 Vigor Reduction Rating[a] (%)[b]	June 25 Giant Green Foxtail Rating[a] (%)[b]	June 25 Velvetleaf Rating[a] (%)[b]	June 25 Lambsquarters Rating[a] (%)[b]	July 5 Corn Height (In.)	Corn Population/A	Corn Yields (Bu/A)
1. Control	____	____	1.0 (0)	9.0 (0)	1.0 (100)	9.0 (0)	9.0 (0)	9.0 (0)	74.75	21184	53.5
2. Control Cultivated	____	____	1.25(0)	3.5 (92.5)	1.25(99)	2.5 (96)	2.25(97)	2.25(97)	78.50	21883	150.3
3. Cyanazine (Bladex)	1.0	pre	1.0 (0)	1.0 (100)	1.25(99)	2.5 (96)	2.25(97)	1.0 (100)	79.25	21340	134.3
+ Alachlor (Lasso)	+1.5										
4. Cyanazine (Bladex)	1.5	early post	2.5 (4)	1.0 (100)	2.25(97)	1.75(98)	4.75(86)	1.0 (100)	76.50	22504	130.1
+ Alachlor (Lasso)	+1.5										
5. Cyanazine (Bladex)	1.0	pre	1.0 (0)	2.25(97)	1.5 (98.5)	1.5 (98.5)	3.25(94)	2.0 (97.5)	82.25	21883	119.5
6. Cyanazine (Bladex)	1.0	early post	1.0 (0)	2.25(97)	1.0 (100)	2.0 (97.5)	5.25(82.5)	1.0 (100)	80.75	22581	133.9
7. Alachlor (Lasso)	1.5	pre	1.0 (0)	1.0 (100)	1.0 (100)	2.25(97)	6.0 (75)	4.75(86)	78.75	21805	109.3
8. Alachlor (Lasso)	1.5	early post	1.0 (0)	1.0 (100)	1.25(99)	1.25(99)	7.75(41)	3.50(92.5)	77.25	20408	111.7
9. Dicamba (Banvel)	0.5	pre	4.0 (10)	1.0 (100)	4.0 (90)	1.75(98)	2.5 (96)	1.0 (100)	75.0	21495	124.4
+ Alachlor (Lasso)	+2.0										
10. Dicamba (Banvel)	0.25	pre	5.25(17.5)	1.0 (100)	3.5 (92.5)	1.25(99)	3.25(94)	1.5 (98.5)	75.5	21107	130.2
+ Alachlor (Lasso)	1.5										
11. Dicamba (Banvel)	0.5	pre	8.0 (68)	1.0 (100)	7.25(57)	2.75(96)	1.25(99)	1.0 (100)	58.75	17848	112.8
+ Alachlor (Lasso)	+2.0	pre									
+ Dicamba (Banvel)	+0.25	early post									
12. Dicamba (Banvel)	0.25	pre	3.75(8.5)	1.0 (100)	3.75(91)	1.75(98)	1.25(99)	1.0 (100)	76.0	21650	124.3
+ Alachlor (Lasso)	+1.5	pre									
+ Dicamba (Banvel)	+0.25	early post									
13. Dicamba (Banvel)	+0.25	pre	3.25(6.5)	2.0 (97.5)	1.50(98.5)	5.5 (80)	5.75(77.5)	3.0 (95)	77.25	20719	121.1
14. Dicamba (Banvel)	0.5	pre	4.25(11.5)	3.25(94)	3.50(92.5)	5.5 (80)	3.0 (95)	1.0 (100)	72.25	20952	126.4
15. Dicamba (Banvel)	0.25	early post	2.5 (4)	3.0 (95)	1.75(98)	8.25(24.5)	3.0 (95)	1.25(99)	78.0	21728	122.5
16. Alachlor (Lasso)	2.0	pre	1.0 (0)	1.0 (100)	1.0 (100)	1.25(99)	5.75(77.5)	5.0 (85)	80.25	23435	124.9
17. Atrazine (AAtrex 80W)	1.0	pre	2.25(3)	1.0 (100)	2.25(97)	2.5 (96)	1.25(99)	1.0 (100)	79.0	22348	128.1
+ Dicamba (Banvel)	+0.25	pre									
18. Atrazine (AAtrex 80W)	1.0	early post	2.0 (2.5)	1.0 (100)	2.0 (97.5)	2.5 (96)	1.25(99)	1.0 (100)	76.25	22038	139.5
+ Dicamba (Banvel)	+0.25	early post									
19. Atrazine (AAtrex 80W)	1.0	pre	1.25(1)	1.0 (100)	1.25(99)	1.75(98)	2.0 (97.5)	1.0 (100)	85.25	22814	144.6
20. Atrazine (AAtrex 80W)	1.0	early post	1.0 (0)	1.0 (100)	1.0 (100)	2.5 (96)	1.5 (98.5)	1.0 (100)	81.25	22659	138.6
Bayes lsd 0.05			1.73	1.39	1.04	1.76	1.91	1.36	5.44	2575.1	30.42

[a] European rating system: 1 = 100% weed control; 5 = 85% weed control
for crop injury 1 = 0%; 3 = 5%, 4 = 10%, 5 = 15%, 8 = 65%

[b] The % is an approximation.

Table 5 Experiment IV: The effect of cyprazine versus atrazine as preemergence and postemergence herbicides for corn.

Treatment	l/bA	Time of Application	June 25 Vigor Reduction Rating[a] (%)[b]	June 25 Giant Green Foxtail Rating[a] (%)[b]	June 25 Fall Panicum Rating[a] (%)[b]	June 25 Velvet-leaf Rating[a] (%)[b]	June 25 Common Lambs-quarter Rating[a] (%)[b]	June 25 Redroot Pigweed Rating[a] (%)[b]	Sept. Corn Yields (Bu/A)
1. Control	———	———	1.0 (0)	9.0 (0)	9.0 (0)	9.0 (0)	9.0 (0)	9.0 (0)	86.4
2. Control Cultivated	———	———	1.0 (0)	2.5 (96)	3.25(94)	2.0 (97.5)	2.0 (97.5)	3.25(94)	141.7
3. Atrazine (AAtrex)	2.0	pre	1.25(1)	1.5 (98.5)	3.5 (92.5)	1.0 (100)	1.0 (100)	1.0 (100)	149.9
4. Atrazine (AAtrex) 80W	2.0	late post	1.0 (0)	5.25(82.5)	6.75(72.5)	1.0 (100)	1.0 (100)	1.0 (100)	129.4
5. Atrazine (AAtrex)	2.0	early post	1.0 (0)	1.5 (98.5)	3.75(91)	1.0 (100)	1.0 (100)	1.0 (100)	135.9
6. Atrazine (AAtrex) + 1 gal/A 11E oil	2.0	early post	1.25(1)	1.0 (0)	4.75(86)	1.0 (100)	1.0 (100)	1.0 (100)	147.9
7. Atrazine (AAtrex) 80W + 1 gal/A 11E oil	2.0	late post	1.0 (0)	6.5 (70)	4.5 (87.5)	1.25(99)	1.0 (100)	1.0 (100)	142.7
8. Cyprazine (Outfox) (1 lb/gal)	0.75	pre	1.0 (0)	4.5 (87.5)	5.5 (80)	5.25(82.5)	1.0 (100)	1.0 (100)	136.2
9. Cyprazine (Outfox) (1 lb/gal)	1.5	pre	1.0 (0)	4.75(86)	6.75(72.5)	5.25(82.5)	1.0 (100)	1.0 (100)	133.2
10. Cyprazine (Outfox) (4 lb/gal)	.75	pre	1.0 (0)	4.50(87.5)	5.0 (85)	5.0 (85)	1.0 (100)	1.5 (98.5)	131.2
11. Cyprazine (Outfox) (1 lb/gal)	0.75	early post	1.0 (0)	1.75(98)	4.0 (90)	4.0 (90)	1.0 (100)	1.0 (100)	136.4
12. Cyprazine (Outfox) (1 lb/gal)	1.5	early post	1.25(1)	1.0 (100)	1.75(98)	1.25(99)	1.0 (100)	1.0 (100)	149.4
13. Cyprazine (Outfox) (4 lb/gal)	0.75	early post	1.0 (0)	1.75(98)	3.25(94)	4.0 (90)	1.0 (100)	1.0 (100)	138.6
14. Cyprazine (Outfox) (4 lb/gal) + 1 gal/A 11E oil	0.75	early post	1.0 (0)	3.50(92.5)	2.25(97)	7.0 (65)	1.0 (100)	1.0 (100)	118.9
15. Cyprazine (Outfox) (4 lb/gal)	1.5	early post	1.25(1)	1.75(98)	3.0 (95)	2.75(96)	1.0 (100)	1.0 (100)	138.9
16. Cyprazine (Outfox) (4 lb/gal) + 1 gal/A 11E oil	1.5	early post	1.0 (0)	1.5 (98.5)	3.75(91)	1.5 (98.5)	1.0 (100)	1.0 (100)	148.0
17. Cyprazine (Outfox) (1 lb/gal)	1.5	late post	1.75(2)	1.5 (98.5)	5.0 (85)	1.0 (0)	1.0 (100)	1.0 (100)	148.8
18. Cyprazine (Outfox) (4 lb/gal)	0.75	late post	1.0 (0)	4.75(86)	5.75(77.5)	1.5 (98.5)	1.0 (100)	1.0 (100)	144.3
19. Cyprazine (Outfox) (4 lb/gal) + 1 gal/A 11E oil	0.75	late post	1.0 (0)	4.0 (90)	6.25(72.5)	1.25(99)	1.0 (100)	1.0 (100)	143.8
20. Cyprazine (Outfox) (4 lb/gal)	1.5	late post	1.75(2)	2.0 (97.5)	4.25(89)	1.50(98.5)	1.0 (100)	1.0 (100)	145.2
21. Cyprazine (Outfox) (4 lb/gal) + 1 gal/A 11E oil	1.5	late post	3.0 (5)	2.75(96)	3.75(91)	1.0 (100)	1.0 (100)	1.0 (100)	145.9
Bayes lds 0.05			.898	2.27	2.06	1.11	.210	.472	23.69

[a] European rating system: 1 = 100% weed control; 5 = 85% weed control; for crop injury 1 = 0%, 2 = 2.5%

[b] The % is an approximation

Herbicides for No-Tillage Corn and Soybeans

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

No-tillage corn and soybean production has increased from virtually no acreage in 1969 to approximately 40% corn and 30% soybeans acreage. The success of no-tillage has been due to a large degree, to the effectiveness of herbicides, since tillage is not done for weed control. The purpose of this field study was to evaluate two contact herbicides, paraquat and glyphosate (Round-up) alone and in combination with several residual herbicides in no-tillage double cropped soybeans following barley and in no-tillage corn planted in a rye cover crop.

Procedure

Two field experiments were established; one study was no-tillage corn planted in rye cover and the second field study was no-tillage double cropped soybeans planted following barley harvest in stubble. Herbicides were applied in 30 gpa and the experimental design was a randomized complete block with 4 replications. Plot size was 10 by 30 feet for corn and 10 by 20 feet for soybeans.

No-tillage corn, Pioneer 3369, was planted May 4, 1973, at the Plant Research Farm in a living rye cover crop. Rye was approximately 3.5 feet tall. The soil texture was a silt loam.

No-tillage soybeans, 'Williams' was planted in barley stubble at the Poplar Hill Research Farm on June 12, 1973. The soil was a Bertie silt loam.

Weed control and corn and soybean injury were visually rated using the European rating system; corresponding percentages are listed in Table 1.

Table 1. European system for evaluating weed and crop responses utilized in these investigations.

Rating Number	Effect on Crop	% Crop injury	% Weed Control	Remarks
1	No injury	0	100.0	Completely Destroyed
2	May be injured	2.5	97.5	Very good control
3	A little injured	5.0	95.0	Good control
4	Injured, but satisfactory	10.0	90.0	Satisfactory
5	Injured, barely satisfactory	15.0	85.0	Just satisfactory
6	Not satisfactory	25.0	75.0	Unsatisfactory
7	Bad injury	32.5	65.0	Poor
8	Very bad injury	65.0	32.5	Very poor
9	100% destroyed	100.0	0	As untreated

Results

No-tillage corn. Paraquat affected rapid kill of rye when compared to glyphosate. However, when observed 1½ weeks after herbicide application glyphosate had affected complete kill of the rye cover crop (Table 2). The predominant weed species present was giant green foxtail. Initially all herbicide combinations containing a residual herbicide were affecting greater than 88% foxtail control. However, when observed on August 4, the only registered residual herbicide combinations effective on foxtail contained simazine. NIA 23486 + NIA 21844 provided 85% or greater foxtail control when observed on August 14; registration procedures for these coded herbicides have been dropped by the company.

Corn yields for the following treatments were similar to the untreated control: paraquat + cyanazine; paraquat + alachlor + atrazine; glyphosate (0.5 lb/A) + alachlor (2.01 lb/A) + atrazine (1.5 lb/A); glyphosate (0.5 lb/A) + atrazine (1.25 lb/A) + simazine (1.25 lb/A); paraquat; and all rates of glyphosate used alone.

No-tillage soybeans. The two predominant weeds present following barley harvest were horseweed (also known as marestail) and common ragweed. Herbicide combinations containing paraquat were effective in controlling these two weeds (Table 3). Glyphosate alone at 0.5 lb/A was somewhat marginally effective in controlling common ragweed. Fluorodifen was not effective in controlling common ragweed or horseweed. Chlorbromuron controlled common ragweed, but not horseweed.

Of the residual herbicides, soybeans were injured by prometryne, 3 lb/A chlorbromuron and metribuzin.

Fall panicum was the predominant weed species germinating after barley harvest. Most residual herbicides affected 85% or better fall panicum control.

Summary

In no-tillage corn, paraquat gave rapid kill of rye in 3 days whereas glyphosate did not affect 100% rye kill until about 1½ weeks after glyphosate treatment. Of the residual herbicides, simazine and simazine atrazine affected best giant green foxtail control. Alachlor + atrazine combinations did not result in the same degree of foxtail control. Control from cyanazine and combinations was fair to good on August 14, but not as high as simazine. NIA 29616 gave good to excellent giant green foxtail control.

In no-tillage soybeans, the following herbicides injured soybeans: RH2915, prometryne, and metribuzin. Chlorbromuron and linuron used alone killed common ragweed but not horseweed (marestail). Fluorodifen alone did not kill marestail or common ragweed. Best control of fall panicum occurred with paraquat plus either RH2915 at 10 lb/A, chlorbromuron, chlorbromuron + alachlor, linuron, or linuron + alachlor. Glyphosate, 1 lb/A + alachlor + linuron also resulted in excellent fall panicum control. To adequately control horseweed (marestail) and common ragweed, 1 lb/A glyphosate was necessary; 0.5 lb/A glyphosate was marginal.

Table 2. Giant green foxtail control and corn yields under no-tillage production planted in a rye cover crop using paraquat or glyphosate alone or in combination with several residual herbicides, 1973.

Treatment[a]	Rate (lb/A)	May 7 Rye Kill (%)[b]	June 4 Giant Green Foxtail Control (Rating)	June 4 (%)[b]	August 14 (Rating)	August 14 (%)[b]	Corn Yields (Bu/A)
1. Control	-	18	5.3	(82)	8.8	(8)	59
2. Atrazine	2.5	25	2.8	(95)	4.3	(89)	128
3. Paraquat	0.25	94	3.0	(95)	4.3	(89)	106
+ Atrazine	2.5						
4. Paraquat	0.25	90	1.8	(98)	2.0	(98)	103
+ Atrazine	1.25						
+ Simazine	1.25						
5. Paraquat	0.25	94	1.0	(100)	3.0	(95)	113
+ Atrazine	0.85						
+ Simazine	1.65						
6. Paraquat	0.25	96	1.0	(100)	1.3	(99)	121
+ Simazine	2.5						
7. Paraquat	0.25	96	3.0	(95)	4.3	(88)	82
+ Cyanazine	2.5						
8. Paraquat	0.25	96	1.8	(98)	4.0	(90)	116
+Cyanazine	1.25						
+Simazine	1.25						
9. Paraquat	0.25	97	3.8	(91)	5.0	(85)	108
+ NIA 23486	0.33						
+ NIA 21844	0.67						
10. Paraquat	0.25	97	1.0	(100)	2.0	(97)	105
+ NIA 23486	0.67						
+ NIA 21844	1.33						
11. Paraquat	0.25	97	1.5	(98)	2.8	(95)	96
+ NIA23486	0.31						
+ NIA21844	0.94						
12. Paraquat	0.25	93	1.5	(98)	2.8	(95)	102
+ NIA 23486	0.62						
+ NIA 21844	1.88						
13. Paraquat	0.25	91	4.3	(88)	8.0	(32)	73
+ Alachlor	2.0						
+ Atrazine	1.5						
14. Glyphosate	0.5	50	4.0	(90)	4.8	(85)	84
+ Alachlor	2.0						
+ Atrazine	1.5						
15. Glyphosate	1.0	52	3.8	(91)	6.8	(66)	104
+ Alachlor	2.0						
+ Atrazine	1.5						
16. Glyphosate	1.5	55	4.5	(87)	6.3	(72)	105
+ Alachlor	2.0						
+ Atrazine	1.5						
17. Glyphosate	0.5	40	1.0	(100)	1.0	(100)	90
+ Atrazine	1.25						
+ Simazine	1.25						
18. Glyphosate	1.0	42	1.3	(99)	1.8	(98)	113
+ Atrazine	1.25						
+ Simazine	1.25						
19. Glyphosate	1.5	48	1.3	(99)	2.8	(95)	97
+ Atrazine	1.25						
+ Simazine	1.25						
20. Glyphosate	0.5	35	8.3	(24)	8.8	(7)	42
21. Glyphosate	1.0	43	7.8	(41)	8.8	(7)	87
22. Glyphosate	1.5	57	8.3	(24)	9.0	(0)	94
23. Paraquat	0.25	93	9.0	(0)	8.8	(7)	70
Bayes lsd 0.05 =		6	1.5		2.0		36

[a]The surfactant Ortho X-77 at 1 pint/100 gal water was used with all paraquat treatments.

[b]The % is an approximation.

Table 3. The effect of residual herbicides on weeds in double cropped no-tillage soybeans following barley harvest used alone or in combination with paraquat or glyphosate, 1973.

	Treatment[a]	Rate (lb/A)	Ratings of Weeds Present After Barley Harvest — June 26: Horseweed (Rating) (%)[b]	June 26: Common Ragweed (Rating) (%)[b]	August 15: Horseweed (Rating) (%)[b]	August 15: Common Ragweed (Rating) (%)[b]	Ratings of Species After Soybean Planting — June 26: Soybean Vigor Reduction (Rating) (%)[b]	August 15: Soybean Vigor Reduction (Rating) (%)[b]	August 15: Fall Panicum (Rating) (%)[b]	Soybean Yield (Bu/A)
1.	Control	-	9.0 (0)	9.0 (0)	9.0 (0)	9.0 (0)	1.0 (0)	1.0 (0)	3.0 (95)	10
2.	Chlorbromuron	1.5	8.5 (17)	1.0 (100)	9.0 (0)	1.0 (100)	1.5 (1)	1.0 (0)	3.3 (94)	12
3.	Chlorbromuron	3.0	6.8 (67)	1.0 (100)	8.5 (17)	2.8 (96)	1.5 (1)	1.0 (0)	3.5 (92)	16
4.	Paraquat	0.5	1.5 (99)	1.0 (100)	2.5 (96)	1.0 (100)	1.0 (0)	1.0 (0)	1.8 (98)	21
	+ Chlorbromuron	1.5								
5.	Paraquat	0.5	1.5 (99)	1.0 (100)	1.3 (99)	1.0 (100)	4.0 (10)	3.3 (7)	3.0 (95)	28
	+ Chlorbromuron	3.0								
6.	Paraquat	0.5	1.0 (100)	1.0 (100)	1.3 (99)	1.0 (100)	1.5 (1)	1.0 (0)	1.8 (98)	28
	+ Chlorbromuron	1.0								
	+ Alachlor	1.5								
7.	Fluorodifen	3.0	8.8 (8)	5.8 (77)	9.0 (0)	8.0 (33)	1.0 (0)	1.0 (0)	1.5 (99)	13
8.	Fluorodifen	4.5	8.0 (33)	9.0 (0)	7.8 (39)	6.8 (67)	1.0 (0)	1.0 (0)	3.5 (93)	11
9.	Fluorodifen	6.0	9.0 (0)	9.0 (0)	9.0 (0)	9.0 (0)	1.3 (1)	1.0 (0)	1.8 (98)	14
10.	Paraquat	0.5	1.0 (100)	1.0 (100)	1.3 (99)	1.8 (98)	1.0 (0)	1.0 (0)	2.0 (98)	26
	+ Fluorodifen	4.5								
11.	Paraquat	0.5	1.0 (100)	1.0 (100)	1.8 (98)	1.0 (100)	3.5 (6)	2.3 (4)	2.0 (98)	25
	+ Prometryne	1.6								
12.	Paraquat	0.5	1.8 (98)	1.2 (99)	1.8 (98)	2.3 (96)	5.5 (20)	3.0 (5)	3.8 (92)	20
	+ Prometryne	2.4								
13.	Paraquat	0.5	1.0 (100)	1.0 (100)	1.3 (99)	1.0 (100)	3.8 (9)	2.8 (4)	2.0 (98)	26
	+ RH 2915	0.5								
14.	Paraquat	0.5	1.0 (100)	1.0 (100)	1.0 (100)	1.0 (100)	4.0 (10)	1.5 (1)	1.0 (100)	29
	+ RH 2915	1.0								
15.	Paraquat	0.5	1.0 (100)	1.0 (100)	1.0 (100)	1.0 (100)	5.0 (15)	2.0 (2)	2.3 (96)	26
	+ Metribuzin	0.625								
16.	Glyphosate	0.5	2.3 (96)	1.7 (98)	2.8 (95)	4.5 (88)	2.0 (3)	1.0 (0)	6.0 (75)	23
17.	Glyphosate	1.0	1.0 (100)	1.5 (99)	1.8 (98)	2.8 (95)	1.0 (0)	1.0 (0)	6.0 (75)	20
18.	Glyphosate	0.5	3.3 (94)	1.0 (100)	4.3 (88)	3.5 (92)	1.3 (1)	1.0 (0)	6.0 (73)	28
	+ Alachlor	1.5								
	+ Linuron	0.5								
19.	Glyphosate	1.0	1.3 (99)	1.0 (100)	1.0 (100)	1.3 (99)	1.3 (1)	1.0 (0)	1.5 (99)	30
	+ Alachlor	1.5								
	+ Linuron	0.5								
20.	Glyphosate	0.5	3.0 (95)	1.0 (100)	2.8 (95)	1.8 (98)	1.3 (1)	1.0 (0)	5.0 (85)	27
	+ Linuron	1.0								
21.	Glyphosate	1.0	1.8 (98)	1.0 (100)	2.5 (96)	1.0 (100)	2.0 (2)	2.3 (4)	2.8 (95)	27
	+ Linuron	1.0								
22.	Paraquat	0.5	1.0 (100)	1.0 (100)	1.0 (100)	1.0 (100)	1.3 (1)	2.3 (4)	5.3 (83)	29
23.	Paraquat	0.5	1.0 (100)	1.0 (100)	1.3 (99)	1.0 (100)	1.0 (0)	1.0 (0)	1.5 (99)	32
	+ Linuron	1.0								
24.	Paraquat	0.5	1.0 (100)	1.0 (100)	1.0 (100)	1.0 (100)	1.0 (0)	1.0 (0)	1.8 (98)	27
	+ Alachlor	1.5								
	+ Linuron	0.5								
	Bayes lsd 0.05		= 1.3	1.0	1.3	1.9	1.9	n.s.	2.4	8

[a] All treatments with paraquat contain 1 pint of Ortho X-77 surfactant/ 100 gal water.
[b] The % are an approximation.

A Protectant for Corn Injury Caused by EPTC, Butylate and Vernolate

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

The thiocarbamate herbicides, EPTC, butylate and vernolate can cause injury to corn. Although butylate is the safest of these herbicides, corn injury can occur from butylate. Recently Stauffer Chemical Company discovered that the addition of N,N-diallyl-2,2-dichloroacetamide (R-25788) applied as a soil treatment would prevent thiocarbamate injury to corn. In the present study R-25788 was tested as a soil treatment with these thiocarbamate herbicides at elevated rates to ascertain R-25788 potential in presenting thiocarbamate injury to corn.

Procedure

Herbicides were incorporated prior to planting corn on May 11, 1973, with a tractor mounted rototiller at a depth of 3 to 4 inches. Pioneer 3369A corn was planted immediately. Specific herbicide and antidote treatments are listed in Table 1. Herbicides were applied with an experimental bicycle sprayer delivering 30 gpa.

The experimental design was a randomized complete block design with 4 replications. Plot size was 10 by 30 feet. Soil type was Mattapex silt loam. Parameters of corn were taken on the center two rows.

Results

Without the protectant, R-25788, the corn population was reduced with vernolate at 8 and 16 lb/A and with EPTC at 9 lb/A. Vernolate at 8 and 16 lb/A also significantly increased the number of injured plants. With the protectant, none of the thiocarbamate herbicides reduced the corn population; however, even with the protectant, vernolate, at 8 and 16 lb/A,

and butylate at 16 lb/A, did cause a significant number of corn plants to be injured. (Table 1)

Corn yields were reduced by EPTC, 9 lb/A, vernolate, 8 and 16 lb/A without the protectant. Vernolate, 16 lb/A, plus protectant also reduced corn yeilds. Similar results were obtained in 1972 tests with R-25788.

Summary

The protectant, R-25788, prevented corn injury from all rates of EPTC, the 4 and 8 lb/A rates of butylate and only the 4 lb/A rate of vernolate. Corn populations were seriously reduced by vernolate without the protectant.

Table 1. The effect of R-25788 on thlocarbamate injury to corn.

	Treatment	lb/A	Antidote treatment	July 3 Corn Population/A	July 5 Corn Height (inches)	July 11 No. of plants injured/ 150 ft.	Sept. 11 Corn yield (Bu/A)
1.	Control	-	Untreated	18934.3	75.2	0	137.2
2.	EPTC (Eptam)	3	Untreated	18313.6	75.8	.3	127.8
3.	EPTC (Eptam)	6	Untreated	18701.6	75.0	1.8	115.5
4.	EPTC (Eptam)	9	Untreated	12726.4	57.5	2.8	69.1
5.	Butylate (Sutan)	4	Untreated	19089.5	78.8	0	143.8
6.	Butylate (Sutan)	8	Untreated	18468.8	78.3	1.2	143.9
7.	Butylate (Sutan)	6	Untreated	20020.7	71.8	12.5	121.1
8.	Vernolate (Vernam)	4	Untreated	17149.6	71.8	1.0	110.6
9.	Vernolate (Vernam)	8	Untreated	12959.1	51.0	11.2	64.7
10.	Vernolate (Vernam)	16	Untreated	7837.6	28.8	7.5	31.2
11.	Control	-	1.0 lb/A R-25788[a]	22116.0	79.3	0	141.8
12.	EPTC (Eptam)	3	0.25 lb/A R-25788[a]	21495.1	79.5	0	150.7
13.	EPTC (Eptam)	6	0.5 lb/A R-25788[a]	22581.5	80.5	.8	150.4
14.	EPTC (Eptam)	9	1.0 lb/A R-25788[a]	20098.3	77.3	.8	147.5
15.	Butylate (Sutan)	4	0.125 lb/A R-25788[a]	20641.6	80.5	0	145.5
16.	Butylate (Sutan)	8	0.25 lb/A R-25788[a]	19555.2	78.0	.3	143.2
17.	Butylate (Sutan)	16	0.5 lb/A R-25788[a]	21728.0	69.8	18.5	115.1
18.	Vernolate (Vernam)	4	0.25 lb/A R-25788[a]	18158.4	78.0	.8	134.5
19.	Vernolate (Vernam)	8	0.5 lb/A R-25788[a]	22193.6	73.0	8.3	129.4
20.	Vernolate (Vernam)	16	1.0 lb/A R-25788[a]	21417.6	56.2	27.8	83.3
			Bayes $LSD_{0.05}$	3545.2	8.4	6.6	25.1

[a] The antidote was soil incorporated.

Residual Effect of Thirteen Cropping Systems on Corn Yield and Soil Aggregation

E. Strickling
Department of Agronomy

Purpose and Objectives

To determine the residual effect of thirteen cropping systems with two levels of nitrogen (100 N and 200 N) on corn yields and on soil aggregation.

Procedure

Eighty-one plots on Beltsville silt loam soil that had been in thirteen cropping systems during the past 20 years was put in corn. Corn will be continued in these plots each year to determine the residual effect of the cropping system. Soil samples were taken on June 8 for soil aggregation and soil organic matter determinations.

Results

The corn yields, soil aggregation and soil organic matter content are presented in table one. Since all plots were put in corn, it was possible to compare first year corn following a grain or hay crop with second year corn following the same rotation.

Summary

Corn yields were closely correlated with soil aggregation and soil aggregation was best under cropping systems that included alfalfa or pasture crops. Aggregation was also high in the continuous wheat plots which had grown wheat twenty years without plowing.

Second year corn yields were only 80.5% of the first year corn yields and the soil aggregation was only 70% as high as the soil aggregation in the plots in the first year corn.

Table 1. Corn yields, soil aggregate stability, and soil organic matter content in 1973 of plots on Beltsville silt loam soil that had been in thirteen different cropping systems from 1952 to 1973.

Cropping System and Previous Crops	Corn Yields			Soil Aggregation 6/8/73	Soil Organic Matter 6/8/73
	100 N	200 N	Ave.		
	bu/A	bu/A	bu/A	%	%
Cont. Bare Fallow	32.1	21.7	26.9	6.0	.85
Cont. Corn	50.8	49.4	50.1	11.9	1.66
Cont. Soybeans	65.9	66.0	66.0	8.7	1.39
Cont. Bluegrass	135.3	113.8	124.6	45.7	2.24
Cont. Orchardgrass	131.1	123.1	127.1	43.0	2.26
Cont. Wheat	144.5	125.0	134.7	41.9	2.15
C°, W, C	90.4	84.4	87.4	34.3	1.75
C°, W, C, C	94.0	72.1	83.1	21.5	1.75
C, W, C	93.9	98.9	96.4	28.2	1.75
C, W, C C	73.2	58.5	65.9	18.4	1.75
SwC, W, C	100.1	99.4	99.7	26.8	1.78
SwC, W, SwC, C	78.9	57.3	68.1	31.3	1.65
C, S, W, C	96.2	112.4	104.3	25.0	1.81
C, S, W, C, C	88.9	85.8	87.4	14.7	1.84
C, W, H, C	110.6	110.3	110.4	30.2	1.94
C, N, H, C, C	80.9	96.0	85.5	17.3	1.82
C, W, H, H C	95.9	106.5	101.2	24.9	2.07
C, N, H, H, C, C	91.4	113.6	102.5	21.0	1.92
C, W, P, P, P, C	152.3	123.2	137.7	40.6	2.19
C, N, P, P, P, C, C	103.0	93.0	98.0	23.7	1.94
Ave. 1st year corn	105.6	105.0	105.3	30.0	1.90
Ave. 2nd year corn	87.2	82.3	84.8	21.1	1.81

C° = corn with stalks left on; SwC = sweet corn; W = wheat; H = alfalfa hay; P = orchardgrass and ladino clover

Correlation coefficient (r) between corn yield and soil aggregation = +.87 with n = 52.

Effectiveness of Forest and Grass Buffer Strips in Reducing Stream Pollution by Animal Wastes

R. C. Doyle, G. V. Schultz, and D. C. Wolf
Department of Agronomy

Purpose and Objectives

Runoff from agricultural land amended with animal manure has been suspected of contributing to pollution of waterways. With today's environmental concerns, it is necessary to evaluate the pollution potential of the traditional method of agricultural disposal of manure. This experiment was designed to:

1. Determine the distance bacteria such as fecal coliform and fecal streptococcus move in runoff water from manured land.
2. Quantitate the amount of phosphorous, sodium, potassium, and various forms of nitrogen transported in runoff water from manured land.
3. Establish the effectiveness of grass and forest buffer strips in reducing the movement of microbial and chemical pollutants in runoff from manured land.

Procedures

Dairy manure was applied at 40 tons per acre (69% moisture) on two slopes in the University of Maryland Agronomy-Dairy Forage Research Farm, Howard County, Maryland.

The manure above the forest buffer area was spread on a Chester gravelly silt loam with a 4% slope directly above a 30% forested slope. Runoff was collected by means of "dust pan" lysimeters at distances of 0, 25, 50, 75, and 100 feet from the manure. The research area was divided into three

plots and four lysimeters were positioned at each distance down the slope in all plots. A small nearby watershed was selected to serve as a check plot.

The manure above the grass buffer strips was spread on a Chester silt loam with a 12% pasture slope. Runoff was intercepted farther down this 12% slope at distances of 0, 25, 50, 100 and 200 feet. Collection of runoff was accomplished by "dust pan" lysimeters similar to the ones used in the forest area. The area was divided into four plots--three plots below the manured area and a fourth plot isolated by landscape position and metal edging directly adjacent to the manure which served as a check plot. Single samples were collected at 0 feet from the manure and continuous samples were taken 25, 50, 100 and 200 feet from the manure by a mechanical sampling device designed for this project.

Streams below both areas were monitored on a weekly basis and during rains to detect any possible pollution from the manure. Chemical and biological analysis of the runoff samples included ammonium, nitrate, and organic nitrogen, total phosphorous, potassium, sodium, fecal coliform, and fecal streptococcus.

Results

Runoff samples for seven rains have been collected and analyzed. Representative data are presented in Tables 1 and 2. Values given for the manure plots are averages of the three treated plots. Those for the check plot are the averages for only one plot. Values for fecal coliform and fecal streptococcus are not available for the first rain.

Nitrogen analyses from the forest plots do not indicate fecal contamination of runoff at any distance. Nitrogen values of the grass plots were somewhat higher at 0 feet in the manure treated plots than at other distances. Unusually high nitrogen values were obtained from the check plots. Sodium, potassium, and phosphorous show a significant increase at 0 feet in both the forest and the grass manure plots. The microbiological data are inconclusive because of the high variability observed.

Samples taken from the streams below the plots did not indicate any increase over natural background.

Summary

No fecal pollution in runoff water attributable to the manure was detected beyond 0 feet, either on the forest or grass slopes or in the streams below. As the runoff water moved away from the manured area, the concentration of potential stream pollutants reached background levels at a distance of less than 25 feet.

TABLE 1. Averaged chemical and microbiological analyses of runoff samples collected at twenty-five foot intervals in the forest plots.

Rain 2 - Sept. 14, 1974

Distance from manure (ft)	Treatment	NITROGEN				Total Phosphorous (ppm)	Potassium (ppm)	Sodium (ppm)	Fecal Coliform per 100ml	Fecal Streptococci per 100 ml X10^3
		NO_3^--N (ppm)	NH_4^+-N (ppm)	Organic-N (ppm)	Total-N (ppm)					
0	manure	11.6	7.2	11.7	30.5	8.45	99	11.0	175	21.5
	check	8.9	4.3	16.3	24.6	4.02	40	1.5	15	87.0
25	manure	6.2	1.8	5.1	13.1	0.91	31	1.2	22	2.3
	check	14.5	4.7	5.6	24.8	1.02	26	1.5	110	1.4
50	manure	10.7	2.0	N.S. [1/]	N.S.	0.52	21	1.0	155	4.4
	check	21.4	6.4	N.S.	N.S.	1.43	39	1.3	24	1.2
75	manure	7.3	0.9	N.S.	N.S.	0.30	14	0.9	38	1.3
	check	15.2	4.6	N.S.	N.S.	1.83	30	0.9	24	3.6
100	manure	3.4	1.0	N.S.	N.S.	0.30	12	1.0	98	2.8
	check	18.0	3.0	N.S.	N.S.	1.46	32	1.6	4	6.2

[1/] Not enough sample collected for analysis.

TABLE 2. Averaged chemical and microbiological analyses of runoff samples collected at twenty-five foot intervals in the forest plots.

Rain 2 - Sept. 14, 1974

Distance from manure (ft)	Treatment	NITROGEN				Total Phosphorous (ppm)	Potassium (ppm)	Sodium (ppm)	Fecal Coliform per 100ml	Fecal Streptococci per 100 ml X10^3
		NO_3^--N (ppm)	NH_4^+-N (ppm)	Organic-N (ppm)	Total-N (ppm)					
0	manure	1.7	0.7	27.0	29.0	6.89	93.0	5.8	12,500	2.2
	check	0.9	1.2	10.3	11.5	2.25	38.0	1.2	200	8.0
25	manure	0.5	0.7	4.4	5.6	2.24	37.0	2.1	4,500	0.5
	check	1.5	1.6	10.1	13.3	2.94	58.0	1.3	24,000	0.1
50	manure	0.7	1.0	N.S.[1/]	N.S.	1.93	39.0	1.4	8,000	0.3
	check	1.3	1.8	N.S.	N.S.	2.34	34.0	1.5	230	0.3
75	manure	0.9	1.2	N.S.	N.S.	2.95	47.0	1.3	1,280	0.5
	check	0.6	0.5	N.S.	N.S.	2.51	36.0	5.9	30	0.3
100	manure	1.2	0.9	N.S.	N.S.	1.93	33.3	1.3	850	0.3
	check	0.6	0.6	N.S.	N.S.	0.01	13.0	1.1	0	0.0

[1/] Not enough sample collected for analysis.

CROPS & SOILS RESEARCH 1974

DEPARTMENT OF AGRONOMY
AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF MARYLAND

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INTRODUCTION

Research Program in the Department of Agronomy

This report gives the research in progress in the Department of Agronomy. The research program in the Department includes the development of improved crop varieties and improved soil and crop management practices that result in more efficient production. Considerable emphasis is also given to research on soil and water conservation, soil and water use, soil-water pollution, air pollution and the disposal of waste materials.

The wide range of soils and 2.0 million acres of agronomic crops (corn, soybeans, tobacco, small grain, turfgrasses, hay, and pasture) grown in the state with a value of approximately 336 million dollars emphasize the size and importance of the research program in agronomy. To solve crops and soils problems research work is conducted at University Laboratories, on the outlying Experiment Station Farms, and cooperatively with farmers, golf course superintendents, and others throughout the state. The help and cooperation received from the many people in the state in carrying out our research program is greatly appreciated.

James R. Miller
Chairman, Department of Agronomy

P. J. Allen
Acting Director, Maryland Agric. Expt. Sta.

TABLE OF CONTENTS

Page

Introduction . . . . . .

Crops and Soils Research Reports

Influence of Soil Moisture and Acidity on Nitrogen Availability
J. H. Axley and T. Dao 1

Effects of Contact and Systemic Sucker Control Chemicals on Maryland Tobacco, II. Agronomic and Chemical Characteristics
M. K. Aycock, Jr. and C. G. McKee 4

Performance of Maryland Tobacco Varieties and Breeding Lines, 1973
M. K. Aycock, Jr. 9

Breeding for Disease Resistance in Maryland Tobacco, 1974
M. K. Aycock, Jr. 12

Effects of Contact and Systemic Sucker Control Chemicals on Maryland Tobacco Cultivars, I. Sucker Data
M. K. Aycock, Jr. and C. G. McKee 16

Phenotypic Correlations of Weather Fleck with Certain Agronomic and Chemical Traits in Maryland Tobacco
M. K. Aycock, Jr. 22

Performance of Breeding Lines in the Preliminary Variety Test, 1974
M. K. Aycock, Jr. 27

Zinc Fertilization of Soybeans
V. A. Bandel and C. E. Rivard 31

No-Tillage Corn Fertilization
V. A. Bandel 37

Sulfur Fertilization of Corn
V. A. Bandel 52

Effect of Leaching and Breakdown of EPTC plus R-25788 on Corn Injury
G. W. Burt 59

Effects of Seed Placement and Cultivar on EPTC plus R-25788 Injury to Corn
G. W. Burt 63

Effect of Soil Incorporation on Corn Injury to EPTC + R-25788
G. W. Burt 68

Temperate and Soil Moisture Effects on Corn Injury Induced by EPTC and Butylate
G. W. Burt 72

Page

Temperate and Soil Moisture Effects on Corn Injury Induced by EPTC plus R-25788 and Butylate plus R-25788
G. W. Burt 76

Comparison of Johnsongrass Control in Corn and Soybeans
G. W. Burt 81

The Use of Organic Preservatives on Aerobically Stored High Moisture Forage
N. A. Clark and C. C. Sheaffer 85

Alfalfa Variety and Strain Tests
N. A. Clark and A. M. Decker 88

Minimum Tillage Establishment of Forage Species
A. M. Decker and R. F. Dudley 94

Effects of Sewage Sludge and Fertilizer Applications on Crop Yields, Soil Nutrient Status, and Soil Structure
A. M. Decker, D. C. Wolf, E. Strickling, R. L. Chaney, and J. M. Walker 100

Adsorption and Desorption of Zinc by Two Soil Materials that Differed in Cation Exchange Capacity
D. S. Fanning and R. F. Korcak 107

Loess Deposits on the Eastern Shore of Maryland
J. E. Foss, D. S. Fanning, F. P. Miller and D. P. Wagner 112

Control of Rugel's Plantain and Broomsedge in Turf
J. R. Hall 118

Perennial Ryegrass Evaluations
J. R. Hall and A. J. Powell 122

Yellow Nutsedge Control in Turf
J. R. Hall and J. V. Parochetti 127

Breeding and Evaluation of Kentucky Bluegrass for Turf
J. R. Hall 133

Tee Turf Research
D. T. Hawes 139

Effect of Nitrogen on Tobacco Performance and Correlations of Total Nitrogen Analysis with Tobacco Yields
J. H. Hoyert and V. A. Bandel 144

Regional Tests with Tobacco Sucker Control Agents on Maryland Tobacco
J. H. Hoyert and G. L. Steffens 149

Page

Effect of Sucker Control Agents, Method of Application and Time of Harvest on Maryland Tobacco
J. H. Hoyert 152

Performance of Barley Varieties and Breeding Lines in Maryland 1974
J. W. Johnson 157

Performance of Wheat Varieties and Breeding Lines in Maryland 1974
J. W. Johnson 160

Double Cropping Soybeans After Wheat and Barley
J. W. Johnson, F. R. Mulford, L. H. Smith, and W. J. Varano 163

Test Lodging Resistance of Maryland Tobacco Varieties with a Wind Making Machine
C. G. McKee and M. K. Aycock, Jr. 166

Irrigation with Maryland Tobacco
C. G. McKee 169

Low Plant Population Studies with Maryland Tobacco
C. G. McKee 172

Comparison of Double-Crop, No-Tillage Corn, Sorghum and Sunflowers for Silage
J. H. McNemar, C. C. Sheaffer and N. A. Clark 176

Population Management Studies with Sunflower Silage
J. H. McNemar, C. C. Sheaffer and N. A. Clark 179

The Response of Alfalfa to Fertility, Irrigation, and Cutting Management
J. H. McNemar, N. A. Clark 183

Response of Corn and Soils to Long-Term No-Tillage and Subsoil Practices
F. P. Miller. 188

Effects of Different Sources of Chloride on the Uptake of Chloride and the Balance of Nutrients in Maryland Air-Cured Tobacco
C. L. Mulchi and W. W. Newcomb 194

Effects of Chloride on Maryland Tobacco
C. L. Mulchi and W. W. Newcomb 200

Salt Spray Effects on Yield and Vegetative Nutrient Contents In Soybeans
C. L. Mulchi and J. A. Armbruster 206

Influences of Salt Spray on Yields and Metabolic Index Values for Corn
C. L. Mulchi and J. A. Armbruster 213

Page

Evaluating Quality in Maryland Air-Cured Tobacco
C. L. Mulchi 219

Spraying Soybeans with Benomyl ("Benlate") for Disease Control - 1974
F. R. Mulford and J. G. Kantzes 226

Control of Wheat Diseases with Foliar Fungicides - 1974
F. R. Mulford and J. G. Kantzes 231

Residual Effect of Thirteen Cropping Systems on Corn Yield and Soil Aggregation
E. Strickling 235

Effect of NaCl on Soil Microbiological Properties
D. C. Wolf and R. W. McCormick 240

Nitrogen Relationships in Sewage Sludge-Amended Soils
D. C. Wolf and G. C. Stanton 245

Influence of Soil Moisture and Acidity on Nitrogen Availability

T. H. Dao and J. H. Axley
University of Nebraska and
Department of Agronomy

Purpose and Objectives

Soil moisture and acidity were thought to influence the quantity of nitrogen the soil releases to the crop as well as the amount of the added fertilizer nitrogen the crop can get. Because nitrogen fertilizers are scarce and costly, it was decided that a study of this might be beneficial to all of us in agriculture as better nitrogen knowledge should result in improved use.

The objectives were:

1. To determine loss of fertilizer nitrate nitrogen from soils at different moisture levels in the absence of leaching.
2. To determine the release of native soil nitrogen to the crop as influenced by moisture and acidity.

Procedure

A Hagerstown silt loam, a Chester loam, and an Othello silt loam were chosen. The moisture level in these three soils at 0.3 atms tension was 31.2%, 28.1%, and 23.5% respectively. Other moisture levels were then adjusted from these.

After the soluble nitrogen in the soil had been removed by leaching with a saturated solution of calcium sulfate, the soils were fertilized with calcium nitrate at 115 lbs/acre of nitrogen. As the nitrogen in calcium nitrate was tagged with the heavy isotope of nitrogen ^{15}N, the gains and losses of available nitrogen in the soil could be traced.

Results

Usually well-fertilized crops obtain about one-half of their nitrogen from soil organic matter except, (1) during a drought when soils fail to release enough of the nitrogen from the organic matter, and, (2) when the soil is saturated with water and the available nitrogen in the soil, both from the fertilizer nitrogen and from the organic matter nitrogen is lost to the atmosphere by a process known as dinitrification. Table 1 shows both of these effects in soils.

When soils contain the proper quantity of moisture, soil acidity controls the release of native nitrogen with the best release occurring in the pH range of approximately 5.9 to 6.6. Soils with pH values above and below this range do not furnish as much nitrogen to the crop. Data in Table 2 demonstrated the influence of soil acidity on the release of available nitrogen.

The results of this research show that the addition of nitrogen fertilizers to soils resulted in reduced nitrogen release from the organic matter.

Summary

Dry soils release little nitrogen from soil organic matter for plant growth. Soils saturated with water can often lose most of their available nitrogen by dinitrification. Soils containing enough moisture for crop growth release the most nitrogen.

Maryland soils release more nitrogen for crop growth when the pH is within the range of - "5.9 to 6.8."

Table 1. Relative lbs of available nitrogen found in 3 soils at 4 moisture levels.

Soil Moisture	Available soil nitrogen and % soil moisture					
	Chester L. lbs/acre	Moist. %	Othello Si. L. lbs/acre	Moist. %	Hagerstown Si. L. lbs/acre	Moist. %
Air dry	25.0	4	7.0	2	1.2	3
Moderate moisture	86	25	24	21	54	28
High moisture	90	30	24	26	12	34
Saturated	6	46	14	31	--	48

Table 2. Relative lbs of available nitrogen found in 3 soils at 3 ranges in pH.

Soil pH	Available soil nitrogen		
	Chester L. lbs/A	Othello Si.L. lbs/A	Hagerstown Si.L. lbs/A
4.9-5.4	67	27	47
5.9-6.8	84	195	117
7.4-7.8	21		48

Table 3. The average amount of nitrogen release from soil organic matter in 3 nitrogen fertilized and 3 unfertilized soils.

Soil Temperature	Relative lbs of available nitrogen Average of three soils Fertilized with 115 lbs. of nitrate fertilizer lbs/A	 No fertilizer nitrogen lbs/A
60	16.8	36.6
73	44.5	55.7
86	64.2	80.3

Effects of Contact and Systemic Sucker Control Chemicals on Maryland Tobacco
II. Agronomic and Chemical Characteristics

M. K. Aycock, Jr. and C. G. McKee
Department of Agronomy

Purpose and Objectives

The effects of sucker control chemicals on the various agronomic and chemical characteristics of Maryland tobacco are of considerable interest. Controlled sucker growth generally results in increased yields of cured leaf, higher dollar returns, and reduced labor cost. Working with Maryland tobacco Spaulding et al. (6), reported no significant differences among sucker control chemicals for yield and value per acre. However in burley and flue-cured tobaccos Steffens et al. (4, 5), have reported increased yields and dollar value with sucker control chemicals.

Additional information concerning the effects of systemic and contact sucker control chemicals on Maryland tobacco is needed. Therefore, this study was conducted to determine the effects of various sucker control chemicals on certain agronomic and chemical characteristics.

Procedures

The study was conducted for two years (1970 and 1971) at the University of Maryland Tobacco Experimental Farm, Upper Marlboro, Md. The five Maryland tobacco cultivars used were Catterton, Md. 10, Md. 59, Md. 609, and Md. 64.

One systemic sucker control chemical (MH-30) and two contact sucker control chemicals (Penar and Off-Shoot-T) were used in the experiment. Recommended rates of application for Maryland tobacco were followed for all chemicals. In 1970, all plots were topped on August 5 and the sucker control chemicals applied the following day. In 1971, all plots were topped on

August 16. Off-Shoot-T was applied four days prior to topping and MH-30 and Penar were applied on the day of topping. Since the initiation of this study, Penar has been withdrawn for sucker control on all types of tobacco.

Plots consisted of a single row spaced 91.4 cm apart. Plant spacing within the row was 61.0 cm. A split-plot design with four replications was used each year. The five cultivars composed the whole plots. Each whole plot was divided into four subplots (treatments): (a) MH-30, (b) Penar, (c) Off-Shoot-T, and (d) a check which consisted of a topped and not-suckered plot. Cultivars and treatments were considered fixed effects (Model 1) and all data were analyzed according to the procedure outlined by Steel and Torrie (3).

Agronomic and chemical data were obtained on four replications. The procedures for obtaining the data on the various agronomic and chemical characteristics are similar to those outlined previously by Fan and Aycock (2).

Results

Mean performance of the five cultivars and three sucker control chemicals for certain agronomic and chemical characteristics is shown in Table 1. In general, the cultivars and sucker control chemicals responded similarly for the two years, as indicated by nonsignificant interactions, therefore, only the combined means are presented

Significant variation among the cultivars was observed for yield, value, price, total nitrogen, and filling capacity (Table 1). Md. 64 had the highest yield and value, and Md. 609 exhibited the highest price. These results are similar to those generally found in Maryland variety tests each year (1).

The three sucker control chemicals had an effect on yield, total alkaloids, and total nitrogen (Table 1). Increased yield of cured leaf was found

with MH-30 when compared with the check. Slight increases in yield were observed for Penar and Off-Shoot-T, but these increases were not statistically different from the check.

The Penar treated plots averaged 1.30% total alkaloids. MH-30 and Off-Shoot-T were similar to the check (1.55%). All sucker control chemicals caused an increase in total nitrogen. The highest total nitrogen content was found for MH-30 and Penar and Off-Shoot-T were intermediate in total nitrogen.

Significant year-to-year variation was observed for three agronomic and chemical characteristics (Table 1). The tobacco grown in 1971 had a higher average price and total nitrogen content, and longer duration of burn than the 1970 tobacco. Such yearly variations are common in Maryland tobacco and these results are similar to previous reports (1).

Summary

Five Maryland tobacco cultivars and three sucker control chemicals were used in a two-year study. The three sucker control chemicals were MH-30, Penar, and Off-Shoot-T. Significant variation among the five cultivars was observed for yield, value ($/A), price ($/cwt), total nitrogen, and filling capacity. The average effect of the sucker control chemicals on the cultivars was an increase in yield and total nitrogen, and these results were due primarily to MH-30. Also the content of total alkaloids varied from 1.30% for Penar to 1.61% for MH-30.

Acknowledgment

The computer time for the statistical analyses was made available through the facilities of the Computer Science Center of the University of Maryland.

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Table 1. Mean agronomic and chemical data from sucker control experiment with Maryland tobacco for 2 years, 1970 and 1971.

Cultivars and chemicals	Yield per acre (lb.)	Value ($/A)	Price ($/cwt)	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec.)	Filling capacity (cc/g)
			Cultivars				
Catterton	1330	925	69.43	1.56	2.24	5.87	7.69
Md. 10	1266	882	69.37	1.42	2.15	7.36	7.58
Md. 59	1178	836	70.78	1.56	2.27	7.31	7.74
Md. 609	1449	1067	73.44	1.46	2.39	8.32	7.62
Md. 64	1768	1243	70.10	1.48	2.20	8.30	7.30
L.S.D. (0.05)	152	123	1.42	N.S.	0.13	N.S.	0.24
(0.01)	210	167	1.92	N.S.	N.S.	N.S.	0.32
			Sucker Control Chemicals				
MH-30	1461	1036	70.73	1.61	2.39	6.88	7.48
Penar	1408	994	70.32	1.30	2.22	7.89	7.62
Off-Shoot-T	1384	983	70.74	1.52	2.27	7.49	7.56
Check	1339	949	70.71	1.55	2.12	7.48	7.69
L.S.D. (0.05)	79	N.S.	N.S.	0.14	0.08	N.S.	N.S.
(0.01)	N.S.	N.S.	N.S.	0.18	0.11	N.S.	N.S.
			Yearly Averages				
1970	1479	1029	69.19	1.59	2.12	4.83	7.55
1971	1317	952	72.06	1.40	2.38	10.04	7.62
1970 vs. 1971	N.S.	N.S.	*	N.S.	**	*	N.S.

N.S. Nonsignificant.
* Significant at the 5% level of probability.
** Significant at the 1% level of probability.

Performance of Maryland Tobacco Varieties and Breeding Lines, 1973

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

The Official Variety Test is the final phase of the breeding program and has three main objectives: (1) To obtain additional information on the varieties presently being grown by the majority of the tobacco farmers, (2) to evaluate advanced breeding lines which appear to have potential as a new variety, and (3) to provide a guide to Maryland tobacco farmers for use in choosing a variety to produce their best crop.

Procedures

Each year the variety tests are conducted at three locations with varying soil types. The tests are located on a Monmouth fine sandy loam at Upper Marlboro, Galestown loamy sand at Davidsonville, and Beltsville silt loam at Dentsville.

The 1973 test which is included in the present report contained six varieties and nine breeding lines. Four breeding lines in the test were developed by the USDA at Beltsville under the direction of H. A. Skoog. Five breeding lines were Agricultural Experiment Station entries with M134, M189, M278 and M478 from the Agronomy Department and B259 from the Botany Department.

Four replications of a randomized complete block design were used at each location. Each plot consisted of one row of 23 competitive plants. The plots were three feet apart and plants spaced two feet apart in the plot. Twenty competitive plants per plot were cut at harvest.

The various agronomic and chemical characteristics measured and methods of data collection have been outlined by Aycock *et al.*, 1972, Maryland Agr. Exp. Sta. MP 798.

Results

The average performance of the varieties and breeding lines compared at three locations in 1973 is shown in Table 1. Md. 64 was the highest yielding variety with 1996 pounds of cured leaf per acre. Md. 872 and Md. 201 produced about 100 pounds less cured leaf per acre than Md. 64, but these two new varieties had a higher dollar per hundredweight value than Md. 64 causing the dollar return per acre for these three varieties to be similar. Md. 609 was the best quality variety with an average of $84.26 per hundredweight. Several breeding lines compared very favorably with the best varieties. M478 was the highest yielding breeding line, but was the lowest entry in the test for dollars per hundredweight. The varieties and breeding lines ranged from 1.60% (M134) to 2.25% (Md. 59) for total alkaloids. Significant variation was noted also among most of the other agronomic, physical, and chemical traits measured. Several breeding lines compared very favorably with the standard varieties for these traits.

Summary

The variety testing program was conducted at three locations in 1973. Several breeding lines with multiple disease resistance appear to have a real potential as new varieties.

Acknowledgment

The computer time for the statistical analyses was made available through the facilities of the Computer Science Center of the University of Maryland.

Table 1. Performance of Maryland tobacco varieties and breeding lines at three locations, 1973.

Variety or breeding line	Yield per acre (lb)	Value $/A	Value $/cwt	Plant height (in)	Leaves per plant	Internode length (in)	Days to flower	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec/leaf)	Filling capacity (cc/g)
Md. 10	1626	1335	82.04	32.6	20.2	1.61	51.5	1.89	2.13	10.9	8.78
Md. 59	1515	1261	83.19	33.4	18.2	1.84	50.3	2.25	2.52	14.1	8.71
Md. 609	1728	1456	84.26	33.2	19.2	1.72	54.7	2.07	2.68	13.0	8.88
Md. 64	1996	1604	80.36	31.6	21.2	1.49	54.3	1.97	2.47	10.7	8.61
Md. 872	1891	1576	83.29	30.7	18.6	1.66	50.2	1.69	2.35	11.4	9.02
Md. 201	1882	1553	82.43	33.0	21.7	1.52	54.4	1.90	2.40	11.6	8.92
M134	1650	1329	80.50	34.0	19.0	1.80	51.2	1.60	2.22	14.1	8.88
M189	1852	1541	83.19	34.5	20.2	1.71	52.0	1.84	2.32	11.1	8.41
M278	1641	1349	82.19	32.7	19.4	1.69	52.3	2.00	2.47	13.0	8.80
M478	1920	1568	81.67	31.3	19.9	1.58	55.7	1.98	2.43	11.7	8.62
J-72-2-1	1797	1476	82.12	32.5	22.2	1.46	57.9	2.11	2.28	11.7	8.97
J-72-222F-1	1769	1454	82.19	33.6	19.7	1.71	51.8	1.83	2.52	12.2	8.79
J-72-225F-1	1819	1489	81.83	33.4	19.4	1.72	52.1	1.69	2.36	13.1	8.58
J-72-305F-1	1826	1522	83.33	34.4	21.1	1.63	54.8	2.22	2.43	11.2	9.08
B259	1567	1300	82.94	34.5	17.8	1.95	48.0	1.99	2.49	11.6	8.76
Mean	1765	1454	82.37	33.0	19.8	1.67	52.8	1.94	2.41	12.1	8.79
L.S.D. (0.05)	112	93	0.88	2.1	1.2	0.08	2.3	0.22	0.20	N.S.	0.34
(0.01)	151	126	1.19	N.S.	1.7	0.11	3.2	0.30	0.27	N.S.	N.S.
C.V. (%)	6.9	7.1	1.2	5.7	5.3	4.2	4.6	10.9	10.5	21.2	4.6

Breeding for Disease Resistance in Maryland Tobacco, 1974

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

A number of diseases attack tobacco grown in southern Maryland; therefore, a large part of the breeding program at the University of Maryland is concerned with disease resistance. In past years the tobacco mosaic virus was one of the most destructive diseases and until 1969, none of the varieties being grown had mosaic resistance. Other diseases which cause some loss in Maryland tobacco each year are black root rot (Thielaviopsis basicola), wildfire (Pseudomonas tabaci), black shank (Phytophthora parasitica var. nicotianae), and fusarium wilt (Fusarium oxysporum var. nicotianae). At present the tobacco breeding program is concerned with developing varieties with resistance to three diseases -- tobacco mosaic, black shank, and fusarium wilt.

Procedures

Breeding for Black Shank Resistance. The sources of resistance to black shank presently being used are from Md. 59 and Md. 609, two varieties released in 1965; and L8, a burley tobacco variety. Md. 59 and Md. 609 were developed by Dr. O. D. Morgan, and the source of black shank resistance was from Florida 301. L8 contains resistance from Nicotiana longiflora.

During January and February, 1974 a modification of a black shank screening procedure utilized at the University of Kentucky was used to screen 100 entries in the F_2 to F_{10} generations. The procedure involved planting approximately 10 to 15 seeds of an entry in two vermiculite-filled 50 ml polypropylene centrifuge tubes. About 4 weeks after seeding the seed-

lings were inoculated with the black shank fungus. Two weeks after inoculation the entries were scored on above ground plant parts (leaves and stems) and the roots. A scoring system of 0, 1, 2, 3 and 4 was utilized for the leaves and stems with a score of 0 representing no symptoms of the disease and a score of 4 representing complete death of all seedlings. A similar system was used for rating the roots. A rating of 0 represented no symptoms (roots white) and 4 represented severe browning of the entire root system.

Breeding for Mosaic Resistance. During the summer of 1973, 34 breeding lines in the F_2 to the F_{10} generations were screened for mosaic resistance in the breeding nursery in the field. Each entry was represented by 28 plants. Just prior to flowering, plants were inoculated with the tobacco mosaic virus by rubbing the leaf with cheesecloth saturated in a solution of the virus. Approximately one week after inoculation, ratings were made on the number of resistant and susceptible plants in each entry. At the time of scoring the resistant plants exhibited small necrotic spots at the site of inoculation while the susceptible plants exhibited the characteristic mosaic pattern of dark and light green areas in the new growth. The necrotic spots of the resistant plants are due to a hypersensitive reaction of the leaf tissue to the virus. When the virus contacts the leaf cells, the cells die at such a rapid rate that the virus cannot spread.

Results

Black Shank Resistance. The results of the screening procedure for black shank resistance are presented in Table 1. Considerable variation was found among the entries for black shank resistance. A few entries appeared to have complete resistance while others were completely susceptible. From the leaf and stem scores, 66% of the entries received a score of 1.5

or better while 50% of the root scores fell within this same range. Entries with a leaf and stem score of 1.5 would probably have adequate resistance under field conditions in southern Maryland.

One reason for the wide variation among the entries for black shank resistance could be due to the nature of inheritance of the resistance. Resistance from the Florida 301 source is believed to be dependent upon two major genes and several modifiers; therefore, through breeding the ultimate objective is to capture the two major genes and accumulate as many of the modifiers as possible. Resistance from L8 is simply inherited and produces plants with a very high level of resistance.

Mosaic Resistance. The results of the tobacco mosaic screening procedure are shown in Table 2. Resistance is determined by a single dominant gene; therefore, the plants fell into one of two classes -- resistant or susceptible. Screening results showed that all entries were resistant. For the entries, 12% appeared to be homozygous or true breeding and 88% were heterozygous or still segregating at the mosaic resistant locus.

Summary

Breeding lines with resistance to black shank and tobacco mosaic are being developed. Screening techniques which are relatively simple and reliable are being used in the greenhouse and summer breeding nursery. Lines with good resistance based on greenhouse and field results were advanced an additional generation in the field nursery during the summer. Selection for plant type and other desirable agronomic traits was done in the field nursery.

Some of the breeding lines which have good resistance and desirable plant types have been observed for agronomic acceptance in preliminary field trials under replicated conditions.

Table 1. Percentage distribution of entries screened for black shank resistance in the greenhouse, 1974. (N = 100).

Score class [a]	Breeding material	
	Leaves and stems	Roots
0.0	7	6
0.5	11	5
1.0	25	10
1.5	23	29
2.0	11	20
2.5	7	18
3.0	6	7
3.5	8	4
4.0	2	1

[a] 0 = completely resistant; 4 = dead.

Table 2. Percentage of resistant (AA), segregating (Aa), and susceptible (aa) genotypes screened for tobacco mosaic resistance, field nursery, 1973. (N = 34).

Genotype	Breeding material, %
AA	12
Aa	88
aa	0

Effects of Contact and Systemic Sucker Control Chemicals on Maryland Tobacco Cultivars
I. Sucker Data

M. K. Aycock, Jr. and C. G. McKee
Department of Agronomy

Purpose and Objectives

The inhibition of axillary bud (sucker) growth in tobacco with sucker control chemicals is a widely used practice. Utilizing contact and systemic sucker control chemicals in a 4-year study with Maryland tobacco, Spaulding *et al.* (4) found fewer suckers per plant with all sucker control chemicals when compared with the topped and not-suckered treatment.

In burley and flue-cured tobaccos Steffens *et al.* (2, 3) have reported good sucker control with maleic hydrazide (systemic sucker control chemical). Similar trends were noted with the methyl caprate (contact sucker control chemical) treatment when compared to the not-suckered treatment.

Additional information concerning the effects of systemic and contact sucker control chemicals on Maryland tobacco is needed. Therefore, this study was conducted with the following objectives: (a) To determine if certain cultivars of Maryland tobacco differed in their ability to produce suckers, and (b) to determine if adequate sucker control could be obtained with systemic and contact chemicals.

Procedures

The study was conducted for two years (1970 and 1971) at the University of Maryland Tobacco Experimental Farm, Upper Marlboro, Md. The five Maryland tobacco cultivars used were Catterton, Md. 10, Md. 59, Md. 609, and Md. 64.

One systemic sucker control chemical (MH-30) and two contact sucker control chemicals (Penar and Off-Shoot-T) were used in the experiment. Recommended application rates were followed for the three chemicals. In 1970, all plots were topped on August 5 and the sucker control chemicals applied the following day. In 1971, all plots were topped on August 16. Off-Shoot-T was applied four days prior to topping and MH-30 and Penar were applied on the day of topping. Since the initiation of this study, Penar has been withdrawn for sucker control on all types of tobacco.

Number of plants per plot in 1970 and 1971 was 12 and 20, respectively. Plots consisted of a single row spaced 91.4 cm apart. Plant spacing within the row was 61.0 cm.

A split-plot design with four replications was used each year. The five cultivars composed the whole plots. Each whole plot was divided into four subplots (treatments): (a) MH-30, (b) Penar, (c) Off-Shoot-T, and (d) a check which consisted of a topped and untreated plot. Cultivars and treatments were considered fixed effects (Model 1) and all data were analyzed according to the procedure outlined by Steel and Torrie (1).

Each year sucker data were obtained from three replications only. Just prior to harvest, all plants were hand suckered and the total number and weight of suckers for each plot were recorded. Suckers per plant and weight per sucker (grams) data were then calculated.

Results

Genetic variation among the five cultivars for sucker production was of considerable interest in this study. This information was available from the check plots of each cultivar; that is, those plots which received no sucker control chemical, but were hand-suckered just prior to harvest.

Sucker data for each cultivar for 1970 and 1971 are given in Table 1. Significant variation was observed among the five cultivars for suckers per plant each year and when averaged over the two years. For the two-year averages, Md. 609 produced the smallest number of suckers per plant (2.99), and Catterton produced the greatest number (5.00). In general, the cultivars producing the greatest number of suckers also exhibited the greatest sucker weight; however, the variation among sucker weights for the cultivars was not significant.

Varying levels of sucker control were obtained with the three sucker control chemicals as indicated in Table 2. For the two-year average, MH-30 treatment resulted in fewer and smaller suckers. Penar and Off-Shoot-T resulted in slightly more sucker growth than MH-30. The high sucker weight observed with Penar was due primarily to a few large suckers obtained in the Penar-treated plots. Some suckers in the leaf axils probably escaped the contact chemical due to the failure of Penar to come in contact with all the leaf axils down the stalk. Therefore, the small number of suckers present would be larger and account for the greater weight per sucker.

In the combined analysis for the two years, the sucker control chemicals x year interaction was significant for suckers per plant and weight per sucker. Both of these interactions were due to differences in magnitude. The number of suckers per plant for the MH-30 treated plots was the same for both years. Complete sucker control was obtained with Off-Shoot-T in 1971, but in 1970 the Off-Shoot-T treated plots averaged 1.97 suckers per plant (Table 2). The Off-Shoot-T treatments were applied after topping in 1970, whereas in 1971, the treatments were applied four days prior to topping when the plants were less mature physiologically. This condition

could have contributed to the differential response observed for the two years. The differential response for weight per sucker over the two years was similar to that found for suckers per plant.

Summary

Five Maryland tobacco cultivars and three sucker control chemicals were used in a two-year study. The three sucker control chemicals were MH-30 (1,2-dihydro-3,6-pyridazinedione-maleic hydrazide), Penar (N,N-dimethyl-1-dodecanamine acetate), and Off-Shoot-T (1-decanol plus 1-octanol mixture). Significant variation was found among the five cultivars for suckers per plant in the combined analysis over the two years. MH-30, Penar, and Off-Shoot-T treated tobacco resulted in 0.04, 0.23, 0.98 suckers per plant, respectively. All sucker control chemicals caused fewer suckers per plant than the untreated check (3.85).

Acknowledgment

The computer time for the statistical analyses was made available through the facilities of the Computer Science Center of the University of Maryland.

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Table 1. Mean sucker data by years for each cultivar obtained from the check plots from sucker control experiment with Maryland tobacco, 1970 and 1971.

Cultivar	Year				2-Year average	
	1970		1971			
	Suckers per plant	Weight per sucker (g)	Suckers per plant	Weight per sucker (g)	Suckers per plant	Weight per sucker (g)
Catterton	4.78	75.7	5.22	20.1	5.00	47.9
Md. 10	4.64	52.2	4.17	17.9	4.40	35.2
Md. 59	3.69	48.2	3.08	16.4	3.39	32.3
Md. 609	3.22	55.0	2.77	15.3	2.99	35.2
Md. 64	4.42	45.4	2.55	9.4	3.48	27.2
Mean	4.15	55.3	3.56	15.9	3.85	35.4
L.S.D. (0.05)	1.03	N.S.	0.82	N.S.	0.63	N.S.
(0.01)	1.42	N.S.	1.14	N.S.	0.85	N.S.

Table 2. Effects of various sucker control chemicals on number of suckers and weight per sucker by years from sucker control experiment with Maryland tobacco, 1970 and 1971.

Sucker control chemicals	Year				2-Year average	
	1970		1971			
	Suckers per plant	Weight per sucker (g)	Suckers per plant	Weight per sucker (g)	Suckers per plant	Weight per sucker (g)
MH-30	0.04	13.3	0.04	4.8	0.04	9.1
Penar	0.37	75.1	0.09	8.8	0.23	42.0
Off-Shoot-T	1.97	51.3	0.00	0.0	0.98	25.8
Check	4.15	55.3	3.56	15.9	3.85	35.4
L.S.D. (0.05)	0.43	15.0	0.35	7.6	0.27	8.2
(0.01)	0.58	20.1	0.48	10.2	0.36	11.0

Phenotypic Correlations of Weather Fleck with Certain Agronomic and Chemical Traits in Maryland Tobacco

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

Agronomic and chemical traits which are highly heritable and exhibit considerable genetic variability, generally enable the plant breeder to shift gene frequencies for a particular trait or traits towards a desirable level. However, while selecting for improvement in one trait, the frequency of genes determining other traits may be increased or decreased depending on the relationship of the various traits. As new cultivars of Maryland tobacco (Nicotiana tabacum L.) are developed with higher levels of tolerance to weather fleck, the correlation of weather fleck with various traits becomes important.

Visual observations by various workers in Maryland tobacco have suggested that weather fleck may cause some reduction in yield. These observations have been primarily visual and data to support this relationship is lacking. Genetic variability is present for susceptibility to weather fleck in Maryland tobacco (1, 2, 4) and this trait appears to be highly heritable (1); however, the relationship of weather fleck with various agronomic and chemical traits is very limited. The results reported in this progress report provide some information on these important relationships.

Procedures

From a study involving five Maryland tobacco cultivars or parents (Gertz, Md. 10, Md. 59, Md. 609 and Md. 64) and 20 F_1 hybrids (all possible crosses among the five parents including reciprocals) data were available

for correlating weather fleck with several agronomic and chemical traits. Data for yield per acre, dollars per acre, dollars per hundredweight (cwt), plant height, leaves per plant, internode length, days to flower, total alkaloids, and total nitrogen were obtained by the procedures normally used in tobacco research as outlined by Aycock et al. (2). Plots consisted of single rows of 25 plants. Twenty plants per plot were cut at harvest, and weather fleck ratings were made between seven and 14 days after harvest on the three remaining competitive plants. Each plant received a score of one to five. A score of one indicated a plant was essentially free of fleck symptoms, while a score of five indicated severe flecking. The number of flecked leaves per plant and the degree of flecking per leaf were considered in scoring.

The experiment was grown for two years, 1969 and 1970, at the University of Maryland Tobacco Experimental Farm, Upper Marlboro, Maryland. Plots were arranged in a split plot design with three replications. There were 10 whole plots per replication and each whole plot contained four subplots (two parents, F_1, and reciprocal F_1).

Results

The phenotypic correlations of weather fleck with certain agronomic and chemical traits are presented in Table 1. Higher incidence of weather fleck appears to be associated with lower yields, earlier flowering, and lower total alkaloids as indicated by the negative r-values. Positive r-values for plant height and internode length suggest that taller plants with wider internodes also tend to be more susceptible to air pollution. Mean weather fleck ratings were higher in 1969 than in 1970 (Table 1); however, the significance of the correlation values was consistent from year to year with the exception of dollars per acre.

The negative phenotypic correlations of -0.36 for weather fleck and total alkaloids suggests that damage from air pollution could be related to lower alkaloids; however, the cause and effect relationship cannot be determined from these data. This relationship seems realistic because Menser and Chaplin (3) have reported that tobacco leaves with a high incidence of weather fleck were lower in alkaloids than lightly flecked leaves.

Early flowering plants tend to fleck more than late flowering plants ($r = -0.49$). In general, leaves which are physiologically mature are highly fleck-susceptible. As the leaves mature from the bottom to the top of the stalk, fleck symptoms also appear in this order. The leaves of early flowering (maturing) plants are physiologically mature earlier than late flowering plants. Therefore longer periods of exposure to air pollution are possible.

The positive relationship of higher incidence of weather fleck with taller plants and wider leaf spacings may be associated with better and longer light penetration into the plant canopy. Such conditions may also provide greater opportunity for oxidant injury. Breeding for a more compact canopy could aid in increasing the level of weather fleck tolerance.

Summary

Phenotypic correlations of weather fleck with nine agronomic and chemical traits in Maryland tobacco were obtained for two years. In general, a higher incidence of weather fleck was associated with lower yields, earlier flowering, lower total alkaloids, taller plants and wider internodes. No significant relationship was observed for weather fleck with dollars per hundredweight, leaves per plant and total nitrogen. Therefore, the development of new cultivars with a compact plant canopy and later flowering should aid in increasing the level of tolerance to weather fleck.

Acknowledgment

The computer time for the statistical analyses was made available through the facilities of the Computer Science Center of the University of Maryland.

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Table 1. Phenotypic correlations of weather fleck with certain agronomic and chemical traits in Maryland tobacco (df = 118).

Trait	Year	
	1969	1970
Yield per acre	-0.24 **	-0.29 **
Dollars per acre	-0.18 *	-0.12
Dollars per cwt	0.06	0.14
Plant height	0.42 **	0.25 *
Leaves per plant	0.03	-0.11
Internode length	0.41 **	0.38 **
Days to flower	-0.49 **	-0.30 **
Total alkaloids	-0.36 **	-0.29 **
Total nitrogen	-0.15	-0.12
Weather fleck mean	3.02	1.96

* Significant at the 5% level of probability.

** Significant at the 1% level of probability.

Performance of Breeding Lines in the Preliminary Variety Test, 1974

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

The initial phase of a breeding program is developmental. Following a desired cross or series of crosses, selection for superior lines is conducted for a number of segregating generations. As new lines reach homozygosity information concerning agronomic and chemical performance is needed. The preliminary variety test is the initial screening process for new breeding lines. Superior breeding lines in this test are then included in the Official Variety Test for further evaluation.

Procedures

In 1973 a group of near homozygous lines with resistance to black shank and/or tobacco mosaic were selected from the tobacco breeding nursery for yield and quality evaluations. These breeding lines were tested in 1974 at Upper Marlboro.

Forty-two breeding lines and three standard varieties (Md. 609, Md. 201 and Md. 872) were included in the test. The experimental design was a randomized complete block with three replications.

Results

The performance of the 42 breeding lines and the standard varieties is shown in Table 1. Entry 40 exhibited the highest yield and dollar return per acre of all entries in the test. Entry 13 had the highest dollar per hundredweight value ($87.77) of all entries, but was not significantly higher than the standard Md. 609. Considerable variation was observed also among the various breeding lines for days to flower and chemical constituents.

After an additional seed increase in the breeding nursery, the top breeding lines from this test will be advanced to the Official Variety Test, and also used as breeding material in future crosses.

Summary

The performance of several breeding lines was very good when compared with the standard varieties. These breeding lines will be advanced to the Official Variety Test, and also used as breeding material in future crosses.

Acknowledgment

The computer time for the statistical analyses was made available through the facilities of the Computer Science Center of the University of Maryland.

Table 1. Performance of advanced breeding lines of Maryland tobacco in a preliminary variety trial at Upper Marlboro, Md., 1974.

Entry	Yield per acre (lbs)	Value		Days to flower	Total alkaloids (%)	Total nitrogen (%)
		$/A	$/cwt			
1	1906	1646	86.39	61.5	1.79	2.87
2	1784	1557	87.31	54.5	1.82	2.71
3	1976	1728	87.44	58.5	1.60	2.93
4	1769	1548	87.53	56.0	1.86	2.83
5	1865	1612	86.45	57.0	1.87	3.09
6	1874	1642	87.60	55.5	1.57	2.75
7	1858	1624	87.40	58.0	1.57	2.89
8	1878	1641	87.30	54.5	1.76	2.78
9	1834	1607	87.62	55.0	1.71	2.95
10	1837	1591	86.59	55.0	1.88	2.88
11	1942	1704	87.71	61.5	1.78	2.77
12	1777	1556	87.52	55.5	1.60	2.72
13	1900	1667	87.77	55.5	1.53	2.69
14	1869	1622	86.74	60.5	1.57	3.09
15	2025	1770	87.40	58.5	1.79	2.90
16	2046	1783	87.12	62.5	1.69	2.72
17	1967	1723	87.56	59.0	1.77	2.85
18	2149	1859	86.66	59.5	1.92	2.89
19	1887	1640	86.90	57.0	1.62	2.81
20	1808	1555	86.02	57.5	1.53	3.07
21	1837	1609	87.60	60.5	1.46	2.79
22	1913	1641	85.76	62.5	1.45	2.58
23	1923	1678	87.28	55.0	1.81	2.79
24	2013	1766	87.76	62.5	1.79	2.93
25	2070	1707	82.51	56.5	1.95	3.08
26	1783	1490	83.51	58.5	2.18	3.13
27	1882	1580	83.89	58.0	1.94	2.80
28	1833	1532	83.56	55.0	1.87	2.89
29	1745	1457	83.42	56.5	2.06	2.65
30	2011	1751	87.08	64.0	2.12	2.82
31	1918	1670	87.09	59.0	2.12	2.74
32	2108	1777	84.38	63.0	1.72	2.74
33	1940	1665	85.90	66.5	1.96	2.83
34	1954	1671	85.60	59.5	2.24	2.28
35	1952	1636	83.84	63.0	2.10	3.02
36	2071	1759	84.95	59.5	1.82	2.73
37	2021	1708	84.51	60.0	1.88	2.58
38	2098	1774	84.63	56.5	2.08	2.73
39	2184	1840	84.34	61.0	1.87	2.82
40	2216	1889	85.20	61.0	1.70	2.66
41	2063	1792	86.87	61.0	1.90	2.77
42	2213	1882	85.09	67.5	1.92	2.77

Table 1. Continued

Entry	Yield per acre (lbs)	Value $/A	Value $/cwt	Days to flower	Total alkaloids (%)	Total nitrogen (%)
Md. 872	2086	1825	87.42	57.5	2.03	2.94
Md. 201	2104	1831	86.89	60.0	1.50	2.61
Md. 609	1911	1675	87.60	58.0	2.11	2.92
Mean	1951	1682	86.22	59.0	1.82	2.82
LSD (.05)	174	152	1.99	5.0	0.40	N.S.
(.01)	231	202	2.64	6.6	0.53	N.S.
C.V. (%)	5.5	5.6	1.4	4.2	13.4	7.9

Zinc Fertilization of Soybeans

V. A. Bandel and C. E. Rivard
Department of Agronomy

Purpose and Objectives

Zinc deficiency has not been identified as a problem with soybeans in Maryland. However, zinc deficiency in corn has occurred on a relatively small acreage in Maryland. Although the corn acreage affected is small, zinc deficiency can seriously reduce corn yields in some localized areas. Because of the seriousness of the problem when it does occur, and the publicity in recent years given to the few cases where a response to zinc fertilization has occurred, many growers are aware of potential zinc deficiency problems in corn and many subsequently have applied zinc to their land often when it is not actually needed. In cases where unnecessary zinc fertilizer applications have been made, there is the potential problem of zinc build-up in the soils to possible toxic levels. High soil zinc could be particularly hazardous for some of the more zinc sensitive plants such as soybeans. Since soybeans often follow corn in the rotation (corn which may have been treated with zinc fertilizers) the objectives of this project were to compare the effectiveness of several rates of row-applied zinc fertilizer which had been applied to corn the previous year to determine any possible effects on soybean yields which may follow the corn. A second objective was to attempt to measure the effectiveness of several rates of row-applied zinc fertilizer placed directly in the soybean row at planting time.

Procedure

In 1974, zinc tests on soybeans were conducted at 3 locations, two in Worcester County and 1 in Wicomico County. In Worcester County,

the sites were selected in which soils were known to be low in zinc according to soil tests and which had also previously resulted in zinc deficiency symptoms on corn. Both Worcester County locations were at the Worcester Vocational Center and were located on a Matapeake soil. In one case, the zinc had been applied directly to the corn in 1973 at rates of 0, 2, 4, 8, and 12 lbs per acre of zinc as zinc oxide and also as 0.3 lbs per acre as a zinc chelate.

In 1974, York soybeans were seeded over these old plots in an effort to measure any residual effect that the previous years' zinc application might have. Adjacent to these plots, Essex soybeans were seeded in early June and similar rates of zinc fertilization were applied in the row at planting time. A similar test was also established at the Poplar Hill Research Farm near Salisbury on a Galestown sandy loam. Essex soybeans were planted in early June with various zinc rates applied directly in the row at planting time. Soil test information for each site is given in Table 1.

The tests in which zinc was applied in the soybean row were seeded with a two-row International corn-planter equipped with an eight-hose squeeze pump. A 10-34-0 liquid fertilizer solution containing various amounts of zinc was placed approximately 2 inches to the side and 2 inches below the seed at planting time. Zinc oxide was applied at rates of 0, 2, 4, 8, and 12 lbs of zinc per acre. At a rate of 400 lbs/acre of 10-34-0, this required solutions containing 0.5, 1, 2, and 3% zinc. A Geigy chelated zinc was also applied at a rate of 0.3 lbs of zinc per acre.

Observations of plant growth were made during the growing season. The uppermost fully developed trifoliate leaf was sampled from each of the plots and collected at the blossom stage for determination

of zinc content. Grain yields were harvested and measured in the fall.

Results

No visible effect of zinc treatment on growth of the soybean plant could be detected at any time during the growing season. Zinc content of soybean leaves was increased significantly both in the year of application as well as in the residual year. (See Table 2) Zinc contents of the Essex soybean leaves grown at the Poplar Hill Farm in 1974 were approximately twice as high as the levels found at most other locations. The soil test indicated that the Galestown sandy loam at Poplar Hill contained 19 lbs per acre of available zinc. This is higher than normally found in most Maryland soils. Apparently this soil had in the past been treated with substantial quantities of zinc, possibly contained in broiler manure.

These tests did not show any yield response, either increase or decrease, due to the zinc application, regardless of whether the zinc had been applied to the corn the previous year or to the soybeans directly in the row at the time of planting.

Summary

Zinc content of the soybean plants was significantly increased due to rate of zinc application, both in the year of application as well as in the second year after application. No response in bean yields occurred in 1974 due to zinc fertilizer applied either in 1973 or in 1974. Some of the soils indicated a very low soil test level of available zinc, and one location indicated an abnormally high level of soil zinc. This work indicated that Maryland soybean growers need not be concerned about reduced soybean yields following zinc applications to corn, especially if the zinc has been applied according to soil test recommendations.

Table 1. Location, soil series and fertility level of 1974 zinc test sites.

County	Farm	Soil Series	pH	P_2O_5	Zinc
				lb/A	
Worcester	Vocational Ctr. 1/	Matapeake	7.0	95M	0.7
Worcester	Vocational Ctr. 2/	Matapeake	7.0	95M	0.7
Wicomico	Poplar Hill 2/	Galestown	6.2	100M	19

1/ York soybeans residual year

2/ Essex soybeans application year

Table 2. Zinc content of York and Essex soybean upper trifoliate leaf in 1974 following variable zinc row application in 1973 or 1974.

County	Variety	Time of Application	Zinc (lb/A) 0	0.3[1/]	2	4	8	9[2/]	12	LSD.05
			ppm							
Worcester	York	Previous Crop	26	24	28	32	39	--	47	5
Worcester	Essex	Direct	34	36	41	46	46	56	50	7
Wicomico	Essex	Direct	55	60	75	82	102	108	112	15

1/ Zinc chelate. All others zinc oxide.
2/ In Granular APP. All others in liquid 10-34-0 @ 200 lb/A

Table 3. Grain yields of York and Essex soybeans in 1974 following variable zinc row applications in 1973 or 1974.

County	Variety	Time of Application	Zinc (lb/A) 0	0.3[1/]	2	4	8	9[2/]	12	LSD.05
			Bu/A							
Worcester	York	Previous Crop	35.6	36.5	37.6	34.1	37.6	---	37.2	N.S.
Worcester	Essex	Direct	32.0	35.2	36.1	32.9	33.3	36.3	30.4	N.S.
Wicomico	Essex	Direct	51.1	51.3	50.7	50.2	52.0	52.6	52.9	N.S.

1/ Zinc chelate. All others zinc oxide.
2/ In Granular APP. All others in liquid 10-34-0 @ 200 lb/A

No-Tillage Corn Fertilization

V. A. Bandel
Department of Agronomy

Purpose and Objectives

The no-tillage concept for corn production has caught on rapidly in Maryland, growing from an estimated 10,000 acres in 1969 to more than 300,000 acres in 1974. However, certain problems concerning fertilization remain to be answered. For instance, are the nitrogen fertilizer requirements for no-tillage corn the same as those for conventionally-tilled corn? Are all nitrogen sources equally as affective on no-tillage corn as on conventionally-tilled corn? And is there an optimum method of application for nitrogen fertilizer materials?

Numerous field observations in Maryland have indicated that no-tillage corn seems to be frequently nitrogen deficient when compared to conventionally-tilled corn fertilized with similar rates of nitrogen. Before this project was initiated, there was little experimental data to indicate whether more or less nitrogen is required for no-tillage corn than for conventionally-tilled corn. The objective of this project was to: 1) Compare no-tillage with conventionally-tilled corn grown on well-drained soils under several rates of nitrogen, 2) Compare the no-tillage with conventionally-tilled corn utilizing several different sources of nitrogen fertilizer, and 3) Compare the no-tillage with conventionally-tilled corn utilizing single and split nitrogen applications.

Procedure

Tests were initiated in the spring of 1974 at the Poplar Hill Research Farm near Salisbury, at the Wye Institute near Queenstown, at the Plant Research Farm near College Park, at the Forage Research

Farm near Clarksville, and at the Maryland Correctional Institute Farm near Hagerstown. The soil types were Mattapex silt loam at Poplar Hill, Bertie silt loam at Wye Institute, Beltsville silt loam at the Plant Research Farm, Delanco silt loam at the Forage Research Farm, and Hagerstown silt loam at the Maryland Correctional Institute Farm. At all locations, a rye cover crop was established in the Fall of 1973 and killed with a quart of paraquat and 2 lbs of atrazine plus simazine per acre the first week of May. Pioneer 3369A corn was planted April 29, 1974 at Poplar Hill, May 8 at Wye Institute, April 30 at Plant Research Farm, and May 2 at the Forage Research Farm. The variety Acco Beachley Hardy 9701F2 was planted at the Maryland Correctional Institute on May 3.

The nitrogen treatments were applied either prior to or immediately after planting. The treatments were as follows:

Test #1. No-tillage versus conventional-tillage and nitrogen rates at 0, 40, 80, 120, and 160 lbs N per acre in a split plot design. The main plots were the tillage treatments and the sub-plots were the nitrogen treatments. At Poplar Hill and the Plant Research Farm the nitrogen source was ammonium sulfate tagged with depleted ^{14}N. At the other three locations, ammonium nitrate was used as the nitrogen source.

Test #2. No-tillage versus conventional-tillage with ammonium nitrate at rates of 0 and 120 lbs N per acre. The nitrogen treatments were; 1) 120 lbs N/A broadcast and none side-dressed, 2) 60 lbs N per acre broadcast and 60 lbs side-dressed, 3) 30 lbs N per acre broadcast and 90 lbs side-dressed, 4) none broadcast and 120 lbs N per acre side-dressed. The experimental design was a split plot similar to that described in Test #1.

Test #3. No-tillage versus conventional-tillage with nitrogen at 0 and 120 lbs N per acre from ammonium nitrate, urea, and 30% nitrogen solution broadcast before planting. Also, in a separate treatment, 120 lbs N per acre from 30% nitrogen solution was side-dressed when the corn was approximately 18 inches tall. The experimental design was a split plot similar to that described in Test #1 and #2.

Phosphorus and potash were applied uniformly to all plots according to the soil test recommendations. Test #1 was conducted at Poplar Hill, Wye Institute, Plant Research Farm, Forage Research Farm, and Maryland Correctional Institute. Test #2 was conducted at Poplar Hill and Wye Institute. Test #3 was conducted only at Poplar Hill.

In addition to visual nitrogen deficiency ratings, silage yields were harvested from Tests 1, 2, and 3 at Poplar Hill and from Test #1 at Wye Institute. Silage samples were analyzed for nitrogen content to determine nitrogen recovery. Grain was harvested from all plots in late September and early October. A mid-season silage yield was taken from Test #1 at Poplar Hill and at the Plant Research Farm. These samples were ground and in addition to their regular nitrogen analysis, were also being analyzed for ^{14}N content.

Results

As in previous years, it was again observed in 1974 that corn grown under the no-tillage system was much more vigorous in growth earlier in the season than the conventionally-tilled corn. Although this difference seemed to carry throughout the growing season, this observation did not hold true at harvest time. Of the eight tests harvested for grain, there was no statistically significant difference in yields between tillage system at the 5% level on 6 of the 8 tests.

Of the other two tests, conventional-tillage gave significantly higher yields (Tables 1, 2, and 3).

A significant response to nitrogen occurred at all locations except at the Maryland Correctional Institute at Hagerstown. At this latter location, the overall lack of response was due largely to moisture stress. The no-tillage plots seemed to respond favorably to nitrogen fertilization wheras the conventional-tillage yields were depressed at the high nitrogen levels.

Grain yields were significantly lower at Poplar Hill and the Plant Research Farm under the no-tillage than under the conventional-tillage system. It is believed these differences occurred primarily because of the severe weed problem at Poplar Hill, and because of extreme moisture stress at the Plant Research Farm during the pollination period. At Poplar Hill, it is believed the reason for failure of the weed control practices in Test #1 was due to exceptionally low soil pH on the surface. Soil samples taken in August from the top inch on the no-tillage plots indicated that where no nitrogen had been applied, the pH was 5.8. But where nitrogen had been applied, in this case as the more acid-forming ammonium sulfate, the pH was 4.4. Apparently this high level of soil acidity prevented the atrazine and simazine from acting properly. Subsequently a heavy growth of Fall Panicum along with some regrowth of the rye occurred. Weed competition was a significant factor depressing yields under no-tillage in this test.

A significant response to nitrogen occurred for all tests except at the Maryland Correctional Institute Farm. Maximum yields occurred at 120 lbs N per acre at Poplar Hill and at 80 lbs N per acre at the Wye Institute, the Plant Research Farm, and the Forage Research Farm.

Split nitrogen applications had no significant effect on grain yields (Table 2). Although a significant response to nitrogen occurred, it made no difference whether the nitrogen was broadcast entirely before planting, split, part broadcast before and part broadcast when the corn was approximately 18 inches tall, or whether the entire amount of nitrogen was side-dressed.

Contrary to results obtained in 1973, nitrogen source seemed to have a significant effect upon grain yields. Regardless of the nitrogen source, the 120 lbs N per acre treatment gave a significant yield increase over the check-plot. Ammonium nitrate produced significantly higher yields than did urea, when one considers the average yields for both tillage treatments. Urea produced significantly less corn grain under no-tillage than under conventional-tillage. However, 30% liquid nitrogen solution also produced significantly less grain than ammonium nitrate, but when averaged across tillage systems was similar to urea. The 30% liquid nitrogen solution applied side-dressed when the corn was 18 inches tall, resulted in grain yields that were almost statistically higher than where the nitrogen solution had been broadcast before planting.

Of the five tests in which silage yields were harvested (Tables 4, 5, and 6), significant yield differences occurred in three, between no-tillage and conventional-tillage systems. Nitrogen rates significantly increased yields at Poplar Hill, Wye Institute, and the Plant Research Farm. Maximum yields occurred at 160 lbs of N at Poplar Hill and 120 lbs of N at Wye Institute and Plant Research Farm. Split and side-dressed nitrogen applications significantly reduced silage yields at Poplar Hill. Maximum silage yields occurred when all the nitrogen had been broadcast pre-plant. The lowest

silage yields occurred after either most or all the nitrogen was side-dressed.

Nitrogen source had a significant effect upon silage yields at Poplar Hill. Maximum silage yields occurred with ammonium nitrate or urea under conventional-tillage. Under no-tillage, yields from both ammonium nitrate and urea were significantly reduced as compared to the conventional-tillage. Silage yields also were significantly reduced following the side-dress application of 30% liquid nitrogen solution on the conventional-tillage corn.

Nitrogen recovery was significantly higher from the conventional-tilled plots than from the no-tillage plots at both Poplar Hill and the Plant Research Farm, where variable nitrogen rates had been applied (Table 7). Increased nitrogen rates resulted in increased nitrogen recovery. Under single and split nitrogen applications, (Table 8), no differences in nitrogen recovery occurred, other than between the check and 120 lbs N per acre and between no-tillage and conventional-tillage after all nitrogen had been side-dressed.

Summary

1) Under the variable soil and climatic conditions of these tests, at some locations the conventional-tillage system produced higher corn yields than the no-tillage. For other locations, the reverse was true. 2) Corn grown under both tillage systems responded to nitrogen favorably. At low levels of nitrogen, conventionally-tilled corn tended to produce higher yields than the no-tillage corn for a given amount of applied nitrogen. Where nitrogen levels were higher, the no-tillage corn tended to produce equivalent or higher yields than the conventional-tillage system for a given amount of applied nitrogen. 3) In

general, both tillage systems responded equally well to split applications of nitrogen from ammonium nitrate. Under the conditions of these tests it made little difference whether the ammonium nitrate was applied in a single broadcast application, in a single side-dressed application, or split between broadcast and side-dressed.

4) Contrary to the '73 data, considerable variability existed in corn response to the two tillage systems to various nitrogen sources. All three nitrogen sources when broadcast tended to produce higher silage yields under the conventional system. However, the 30% liquid nitrogen solution when side-dressed produced significantly lower silage yields under the conventional system. Grain yields were equivalent for ammonium nitrate and the 30% liquid nitrogen solution side-dressed for the no-tillage system. However, urea and broadcast liquid nitrogen produced significantly lower grain yields under the no-tillage system. No similar differences in grain yields were noted in 1973.

Table 1. Grain yield response of no-tillage and conventional-tillage corn at various nitrogen rates at five locations. 1974.

Tillage	N (lb/A) 0	40	80	120	160	Ave.
	Bu/A					
Poplar Hill						
No-tillage	49.1	62.1	94.4	112.9	138.1	91.3*
Conventional	61.2	114.1	145.0	166.8	149.8	126.6
Ave.	55.1	88.1	120.2	137.3	144.0	
N $LSD_{.05}$ = 16.1 Bu, N x Tillage $LSD_{.05}$ = 22.8 Bu						
Wye Institute						
No-tillage	78.1	120.7	151.7	172.4	172.4	139.0
Conventional	92.8	152.4	170.8	175.6	194.6	157.2
Ave.	85.4	136.6	161.2	174.0	183.5	
N $LSD_{.05}$ = 16.6 Bu						
Plant Research Farm						
No-tillage	19.7	31.8	75.2	79.1	77.8	56.7*
Conventional	54.0	79.5	80.0	94.5	108.6	83.3
Ave.	36.8	55.6	77.6	86.8	93.2	70.0
N $LSD_{.05}$ = 18.6 Bu						
Forage Research Farm						
No-tillage	146.2	174.3	183.9	185.5	172.4	172.4
Conventional	140.4	159.2	180.0	170.8	175.1	165.1
Ave.	143.3	166.7	181.9	178.1	173.7	
N $LSD_{.05}$ = 11.2 Bu						
Maryland Correctional Institute						
No-tillage	141.4	167.6	165.5	178.3	193.0	169.2 1/
Conventional	132.5	146.7	154.0	134.4	123.2	138.2
Ave.	137.0	157.1	159.8	156.4	158.1	

* Average for tillage significant at 5% level.
1/ Average for tillage and N x tillage significant at 10% level.

Table 2. Grain yield response of no-tillage and conventional-tillage corn following single and split applications of 120 lb. N/A. 1974.

Tillage	Check	120 Br. 0 S.D.	60 Br. 60 S.D.	30 Br. 90 S.D.	0 Br. 120 S.D.	Ave.
	N (lb/A) Broadcast and/or Sidedressed					
	Bu/A (15.5% H_2O)					
Poplar Hill						
No-tillage	60.6	153.3	157.4	166.6	175.4	142.7
Conventional	74.6	178.4	170.6	171.1	174.4	153.8
Ave.	67.6	165.9	164.0	168.9	174.9	
	N $LSD_{.05}$ = 16.5 Bu					
Wye Institute						
No-tillage	76.8	174.8	185.0	192.5	184.1	162.6
Conventional	66.0	156.6	188.2	181.8	195.2	151.6
Ave.	71.4	165.7	186.6	187.2	189.7	
	N $LSD_{.05}$ = 21.0 Bu					

Table 3. Grain yield response of no-tillage and conventional-tillage corn following applications of 120 lb N/A from three sources. 1974.

Tillage	N Source: Check	Amm. Nitrate [1]	Urea [1]	30% N Solution [1]	30% N Solution [2]	Ave.
	Bu/A					
Poplar Hill						
No-tillage	55.1	144.9	110.7	128.6	156.6	119.2
Conventional	57.8	163.8	157.6	145.9	146.7	134.4
Ave.	56.4	154.3	134.2	137.2	151.6	

$N\ LSD_{.05}$ = 15.0 Bu., N x Tillage $LSD_{.05}$ = 21.2 Bu.

1/ Broadcast pre-plant
2/ Sidedressed when 18 inches tall.

Table 4. Silage yield response of no-tillage and conventional-tillage corn at various nitrogen rates at three locations. 1974.

Tillage	N (lbs/A) 0	40	80	120	160	Ave.
	Tons/A (30% D.M.)					
Poplar Hill						
No-tillage	8.0	8.7	10.8	12.6	15.0	11.0*
Conventional	10.2	14.4	15.6	16.4	18.0	15.0
Ave.	9.1	11.6	13.2	14.5	16.5	
	N LSD$_{.05}$ = 1.0 tons, N x Tillage LSD$_{.05}$ = 1.4 tons					
Wye Institute						
No-tillage	11.0	17.5	19.4	23.3	25.8	19.4*
Conventional	16.5	19.9	24.0	25.9	23.1	21.9
Ave.	13.7	18.7	21.7	24.6	24.4	
	N LSD$_{.05}$ = 2.9 tons					
Plant Research Farm						
No-tillage	8.7	11.3	16.8	22.4	18.9	15.6*
Conventional	11.2	15.5	17.4	19.3	20.8	16.8
Ave.	10.0	13.4	17.2	20.8	19.8	
	N LSD$_{.05}$ = 1.4 tons, N x Tillage LSD$_{.05}$ = 2.0					

* Average for tillage significant at 5% level.

Table 5. Silage yield response of no-tillage and conventional-tillage corn following single and split application of 120 lb N/A. 1974.

Tillage	Check	120 Br. 0 S.D.	60 Br. 60 S.D.	30 Br. 90 S.D.	0 Br. 120 S.D.	Ave.
	---------N (lb/A) Broadcast and/or Sidedressed--					
	----------Tons/A (30% D.M.)----------					
			Poplar Hill			
No-tillage	8.3	22.1	20.6	17.5	19.2	17.6
Conventional	8.7	19.4	19.2	17.6	16.1	16.2
Ave.	8.5	20.8	19.9	17.6	17.7	
	N LSD $_{.05}$ = 2.0 tons					

Table 6. Silage yield response of no-tillage and conventional-tillage corn following application of 120 lb N/A from three sources. 1974.

Tillage	N Source: Check	Amm. Nitrate[1/]	Urea[1/]	30% N Solution[1/]	30% N Solution[2/]	Ave.
	Tons/A (30% D.M.)					
Poplar Hill						
No-tillage	9.4	18.5	19.6	19.3	20.0	17.4
Conventional	9.6	22.4	22.2	20.6	16.0	18.2
Ave.	9.5	20.5	20.9	19.9	18.0	

N $LSD_{.05}$ = 2.1 tons, N x Tillage $LSD_{.05}$ = 3.0 tons

1/ Broadcast pre-plant.
2/ Sidedressed when 18 inches tall.

Table 7. Nitrogen recovery by no-tillage and conventional-tillage corn at various nitrogen rates at two locations. 1974.

Tillage	N (lb/A) 0	40	80	120	160	Ave.
	lbs/A					
Poplar Hill						
No-tillage	35.8	33.0	49.0	71.1	95.6	56.9*
Conventional	44.4	68.0	89.0	111.8	124.3	87.5
Ave.	40.1	50.5	69.0	91.5	110.0	
	N LSD$_{.05}$ = 8.5 lbs., N x Tillage LSD$_{.05}$ = 12.0 lbs.					
Plant Research Farm						
No-tillage	36.4	44.7	73.6	119.0	106.2	76.0*
Conventional	43.4	69.2	105.4	121.1	152.0	98.2
Ave.	40.0	57.0	89.5	120.1	129.1	
	N LSD$_{.05}$ = 13.6 lbs., N x Tillage LSD$_{.05}$ = 19.2 lbs.					

* Average for tillage significant at 5% level.

Table 8. Nitrogen recovery by no-tillage and conventional-tillage corn following single and split application of 120 lbs N/A. 1974.

Tillage	Check	120 Br. 0 S.D.	60 Br. 60 S.D.	30 Br. 90 S.D.	0 Br. 120 S.D.	Ave.
	N (lb/A) Broadcast and/or Sidedressed					
	lbs/A					
Poplar Hill						
No-tillage	36.4	109.8	118.3	107.1	131.5	100.6
Conventional	39.8	119.8	120.3	114.1	83.8	95.6
Ave.	38.1	114.8	119.3	110.6	107.7	

$N\ LSD_{.05}$ = 18.5 lbs., N x Tillage $LSD_{.05}$ = 26.2 lbs.

Sulfur Fertilization of Corn

V. A. Bandel
Department of Agronomy

Purpose and Objectives

Several years ago concern developed among Maryland agronomists regarding possible sulfur deficiencies on Maryland soils. Some reasons for this concern were as follows; 1) A trend toward the use of higher analysis fertilizers containing less sulfur, 2) Less use of high sulfur fuels, thus reducing the amount of sulfur dioxide present as an atmospheric source of sulfur for plants, and 3) Higher crop yields, particularly in a mono-culture situation which places a heavier drain upon sulfur from the soil. The objective of this project was to determine if corn would respond to sulfur fertilization when grown on soils receiving little or no known sulfur fertilization during the past several years.

Procedure

Earlier work conducted in Maryland indicated that corn ear leaf sulfur levels sometimes occurred in the deficiency range. Nitrogen to sulfur ratios also sometimes were wider than generally considered optimum for efficient forage utilization by ruminants. Based upon this work, it was decided that corn sulfur fertilization studies should be continued in Maryland in 1974.

Field tests were extablished in 1974 at six locations throughout Maryland. The test locations were selected from fields which had reportedly received little or no sulfur fertilization for the past several years. Sulfur was applied at rates of 0, 50, 200, and 400 lbs per acre from gypsum or anhydrite early in the spring. Anhydrite, 22% S, was the principle source of sulfur used. Gypsum, 17.2% S, was utilized at one location in Worcester County in order to provide a

comparison between gypsum, ($CaSO_4 \cdot 2H_2O$) and anhydrite, ($CaSO_4$). Corn ear leaf samples were collected at tasselling. All plant samples were analyzed for nitrogen and sulfur. Grain yields were harvested from 5 of the 6 plots in September. The locations and soil type for each test are given in Table 1.

Results

Grain yields obtained at each location are given in Table 2. No statistically significant response to sulfur was obtained at any of the locations. At the Dorchester County location, a trend was apparent in which yields increased from 155.6 bushels per acre with no sulfur to 168.6 bushels per acre with 400 lbs/acre of sulfur. The results, however, were not statistically significant.

Sulfur content of the corn ear leaves is given in Table 3. Sulfur fertilization resulted in a significant increase in sulfur content at 3 of the 5 locations. In 1973 at the Dorchester County location, an increase in sulfur content of the whole young plant occurred, but no significant increase occurred in the ear leaves. However, in 1974, the sulfur content of the ear leaf increased from 0.13% S with no sulfur to 0.18% S at the 400 lb per acre level. In 1973 a significant increase in S uptake occurred in Worcester County at the Brunning Farm. This was repeated in 1974. Similarly, a significant increase occurred at the Miltonberger Farm in Allegany County in 1973 which also was repeated in 1974. It was apparent from this data that an application of at least 200 lbs per acre of sulfur was necessary in order to obtain a significant increase in the plant uptake of sulfur. The 50-lb per-acre rate did not always result in a significant increase in the sulfur content of the ear leaf. Although, 50 lbs did seem to be sufficient at the Allegany County location in

both 1973 and 1974.

The nitrogen to sulfur ratio of the corn ear leaves at tasselling is given in Table 4. In 1973, a statistically significant reduction in nitrogen to sulfur ratio of the corn ear leaf occurred with increasing sulfur fertilization at the Brunning Farm in Worcester County. A significant response at this location did not occur in 1974, although a consistent trend did appear in which the nitrogen to sulfur ratio declined from 24.7 with no sulfur to 15.7 with 400 lbs/acre of sulfur. A significant reduction in the nitrogen to sulfur ratio occurred at the Dorchester, Talbot and Allegany locations. Again, it was apparent that at most locations approximately 200 lbs of sulfur per acre were necessary to significantly narrow the nitrogen to sulfur ratio. Although a significant reduction in nitrogen to sulfur ratio did occur at the Allegany County location with just 50 lbs of S per acre.

Summary

No statistically significant yield response to sulfur fertilization occurred on corn in the 1974 tests. An apparent trend occurred at one location, indicating only the possibility of a yield response.

Sulfur levels of the ear leaves were increased with increasing sulfur fertilization at 3 of the 6 locations. At 2 of the locations, where no significant increase occurred, apparent trends indicated increased sulfur uptake with increased sulfur application rate.

The nitrogen to sulfur ratios were significantly decreased or narrowed at 3 of the 6 locations as sulfur fertilization rates were increased. Trends indicating a possible response in a narrowing of the nitrogen to sulfur ratio were apparent also at the other 3 locations.

Apparently, even though sulfur levels seem to be low in many of the fields tested, no grain yield response was obtained from sulfur fertilization. Sulfur fertilization resulted in some increased sulfur uptake and subsequent narrowing of the nitrogen to sulfur ratio which may be important in improved feed quality. This work indicated that there apparently is not serious need at the present time for growers to consider sulfur applications to their crops.

Table 1. Yield response of corn in Bushels per acre as influenced by sulfur fertilization. 1974.

Location County-Farmer	Pounds of Sulfur per acre					
	0	50[1/]	200[1/]	400[1/]	200[2/]	$LSD_{.05}$[3/]
	Bu/A[4/]					
1. Worcester-Brunning	91.0	100.3	96.0	103.4	111.2	N.S.
2. Worcester-Pusey	123.4	117.6	116.7	119.2	-----	N.S.
3. Dorchester-Eberspacher	155.6	164.5	168.2	168.6	-----	N.S.
4. Talbot-Spies	155.5	152.5	157.8	158.2	-----	N.S.
5. Cecil-Miller	135.2	112.4	134.3	118.7	-----	N.S.
Ave.	132.1	129.5	134.6	133.6		

1/ S from anhydrite (22.0% S) -- $CaSO_4$

2/ S from gypsum (17.2% S) -- $CaSO_4 \cdot 2H_2O$

3/ Least significant difference at 5% probability level

4/ Grain @ 15.5% H_2O

Table 2. Sulfur content of corn ear leaves at tasselling under four rates and two sources of sulfur. 1974.

Location County-Farmer	Pounds of Sulfur per acre 0	50[1/]	200[1/]	400[1/]	200[2/]	$LSD_{.05}$[3/]
	% S					
1. Worcester-Brunning	0.10	0.10	0.14	0.16	0.12	0.04
2. Worcester-Pusey	0.14	0.18	0.18	0.19	----	N.S.
3. Dorchester-Eberspacher	0.13	0.15	0.19	0.18	----	0.04
4. Talbot-Spies	0.14	0.15	0.16	0.18	----	N.S.
5. Cecil-Miller	0.16	0.16	0.16	0.16	----	N.S.
6. Allegany-Miltenberger	0.12	0.15	0.19	0.20	----	0.03
Ave.	0.13	0.15	0.17	0.18	0.12	

1/ S from anhydrite (22.0% S) -- $CaSO_4$

2/ S from gypsum (17.2% S) -- $CaSO_4 \cdot 2H_2O$

3/ Least significant difference at 5% probability level.

Table 3. Nitrogen to sulfur (N/S) ratio of corn ear leaves at tasselling under four rates and two sources of sulfur. 1974.

Location County-Farmer	Pounds of Sulfur per acre 0	50 [1/]	200 [1/]	400 [1/]	200 [2/]	LSD .05 [3/]
	N/S					
1. Worcester-Brunning	24.7	23.7	19.2	15.7	20.6	N.S.
2. Worcester-Pusey	18.4	14.4	14.4	14.2	----	N.S.
3. Dorchester-Eberspacher	19.2	15.8	14.1	14.0	----	3.5
4. Talbot-Spies	17.3	17.9	14.8	14.6	----	2.6
5. Cecil-Miller	18.5	17.5	17.5	16.8	----	N.S.
6. Allegany-Miltenberger	14.0	10.6	7.7	7.7	----	2.8
Ave.	18.7	16.6	14.5	13.7	20.6	

1/ S from anhydrite (22.0% S) -- $CaSO_4$

2/ S from gypsum (17.2% S) -- $CaSO_4 \cdot 2H_2O$

3/ Least significant difference at 5% probability level.

Effect of Leaching and Breakdown of EPTC plus R-25788 on Corn Injury

G. W. Burt
Department of Agronomy

Purpose and Objectives

EPTC plus R-25788 has caused injury to corn in the field. Increases in toxicity of EPTC plus R-25788 in corn seedlings could result from removal of R-25788 but not EPTC from the soil through differential rates of leaching or breakdown in the soil. The following experiments were conducted to investigate these possibilities.

Procedures

Leaching. Immediately after planting corn 0 to 20 cm of distilled water was added to each pot. Water was drained out of the bottom of the pots if greater than 3 cm of water was applied. Each point on Figure 1 is a mean of 5 replications each of which is a mean of 4 plants.

Breakdown. Four corn seeds were planted in two pots immediately after filling the pots with herbicide treated soil or control soil. Every 3 days thereafter an additional planting was made. Planting occurred every 3 days until 21 days after soil treatment. The soil in all pots remained moist for the entire experimental period, and data was recorded 10 days after planting. This experiment was repeated 4 times.

Results

It is possible that EPTC becomes separated from R-25788 while leaching through the soil profile. This separation could cause injury especially if the R-25788 was leached faster than EPTC. Leaching did not, however, increase EPTC plus R-25788 injury to corn under any of the leaching rates studied (Figure 1). The highest rates of water leached decreased the toxicity of EPTC plus R-25788 more than four times to that compared to the lowest rate

of water application (Figure 1). The progressive decrease in toxicity with an increase in water leached through the soil indicates that the mobility of R-25788 in the soil is equal to or less than the mobility of EPTC.

A change in the ratio of EPTC:R-25788 in the soil could occur if decomposition rates of these two chemicals differ. If R-25788 decomposes faster than EPTC this could result in an increase in toxicity of corn seedlings. Planting of corn seeds 0 to 21 days after herbicide application to the soil indicated, however, that no increase in toxicity occurred throughout the growth period (Figure 2). Toxicity decreased with time and at 21 days very little (12%) height reduction in corn shoot height was observed. R-25788 does not, therefore, appear to be decomposed in the soil faster than EPTC.

Summary

Experiments were conducted to determine if R-25788 leached faster or decomposed faster than EPTC. No evidence was obtained to support either one of these hypotheses.

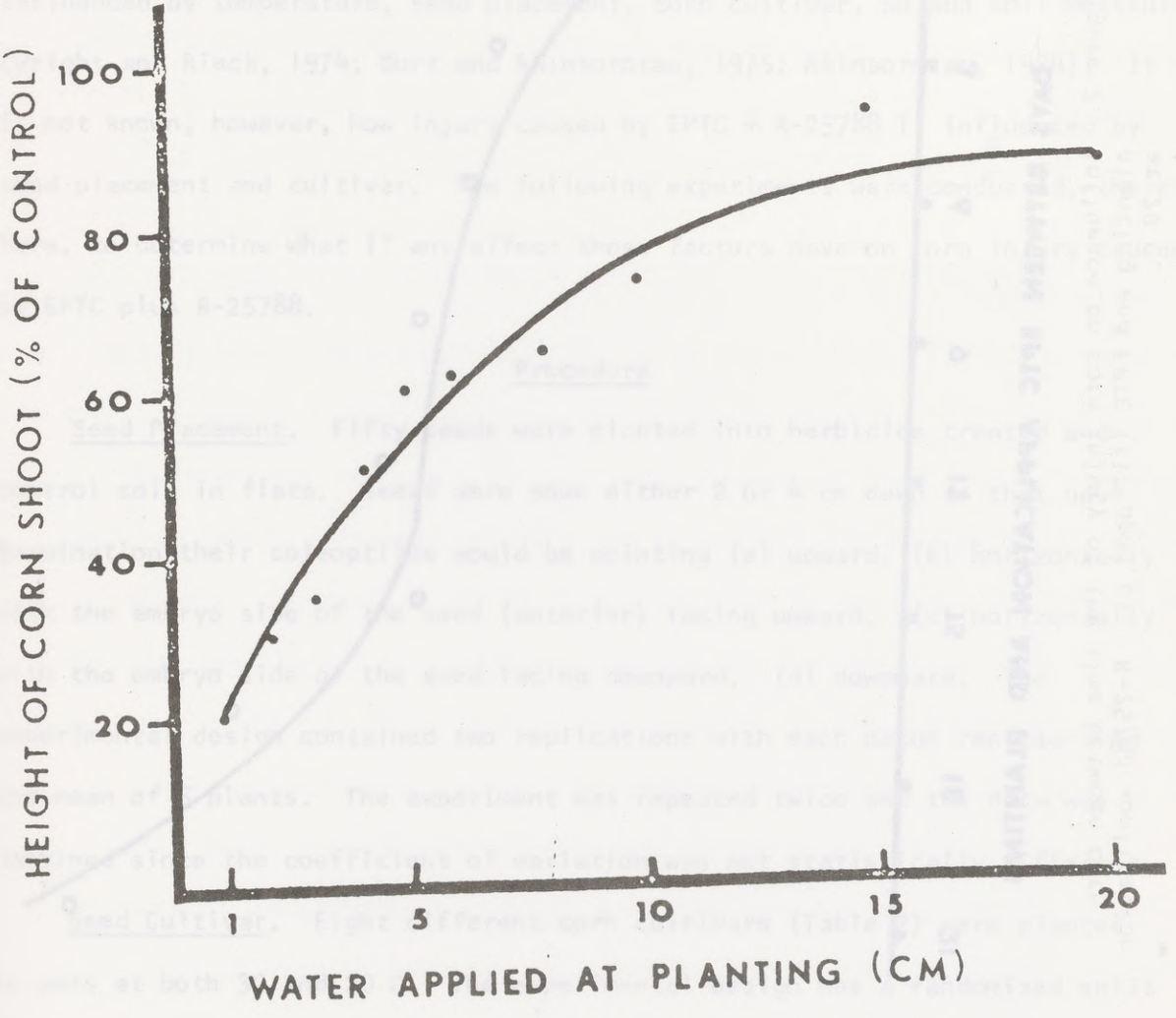

Figure 1. Corn shoot growth at 30 C versus quantity of water applied to pots at time of planting. Each pot contained 4 corn seeds in soil treated with 112 ppm of EPTC plus R-25788.

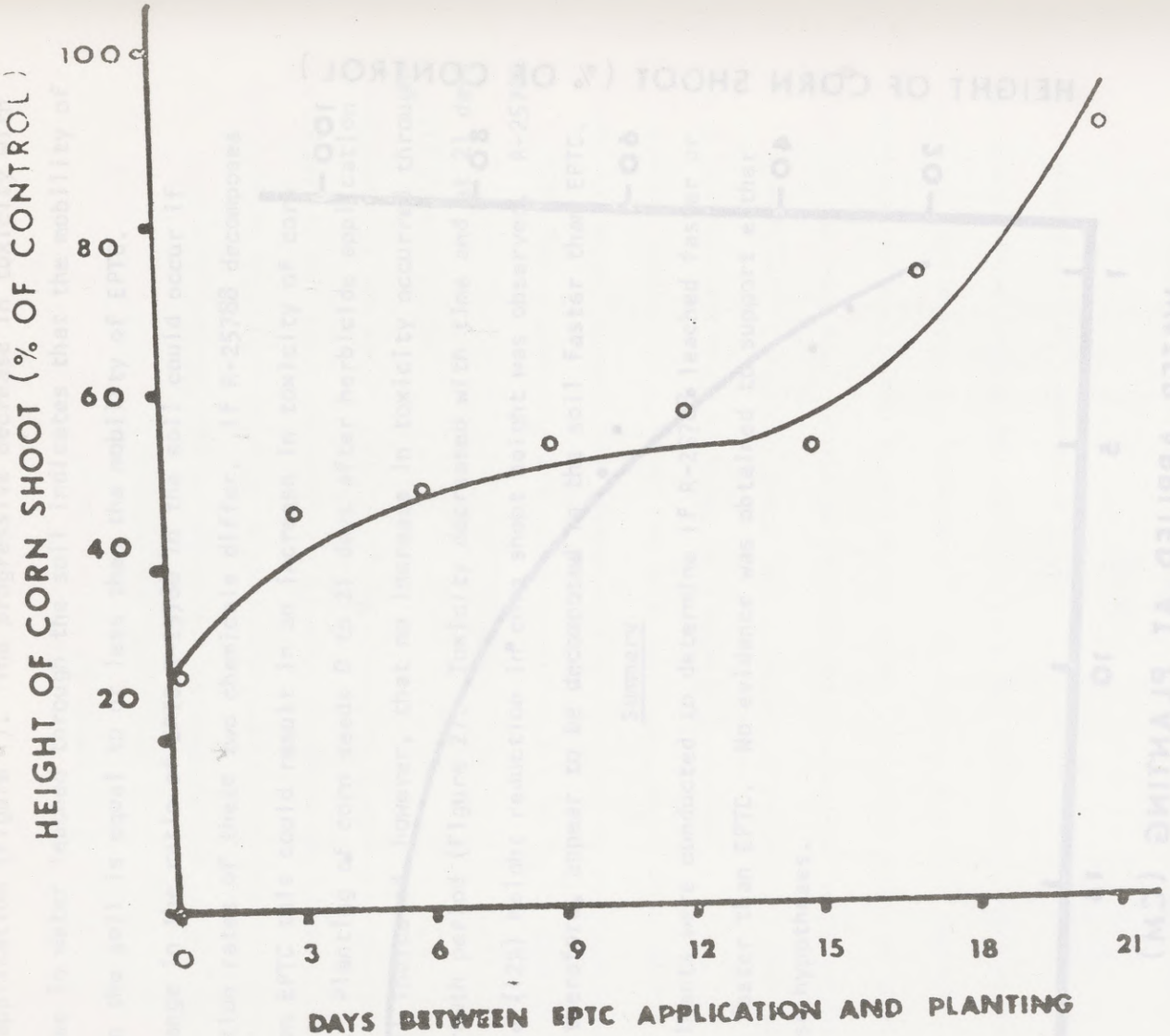

Figure 2. Influence on corn injury of the time between corn planting and EPTC (112 ppm) plus R-25788 application at 20 C.

Effects of Seed Placement and Cultivar on EPTC Plus R-25788 Injury to Corn

G. W. Burt
Department of Agronomy

Purpose and Objectives

Injury caused by thiocarbamate herbicides not mixed with R-25788 is influenced by temperature, seed placement, corn cultivar, pH and soil moisture (Wright and Rieck, 1974; Burt and Akinsorotan, 1975; Akinsorotan, 1974). It is not known, however, how injury caused by EPTC + R-25788 is influenced by seed placement and cultivar. The following experiments were conducted, therefore, to determine what if any effect these factors have on corn injury caused by EPTC plus R-25788.

Procedure

Seed Placement. Fifty seeds were planted into herbicide treated and control soil in flats. Seeds were sown either 2 or 4 cm deep so that upon germination their coleoptiles would be pointing (a) upward, (b) horizontally with the embryo side of the seed (anterior) facing upward, (c) horizontally with the embryo side of the seed facing downward, (d) downward. The experimental design contained two replications with each datum representing the mean of 5 plants. The experiment was repeated twice and the data was combined since the coefficient of variation was not statistically different.

Seed Cultivar. Eight different corn cultivars (Table 2) were planted in pots at both 30 and 20 C. The experimental design was a randomized split block with two replications with temperature effects being the main block effects. Each datum was the mean of 4 plants growing in one pot; the experiment was repeated 3 times.

Results

The depth and position of the corn seed was shown to influence the

toxicity of EPTC plus R-25788 (Table 1). Generally, seeds planted at a depth of 2 cm were injured less than at 4 cm. Seeds germinating with their coleoptiles pointing upward were also injured less than those pointing downward. Seeds whose coleoptiles were pointing horizontally were less injured if their anterior side was facing upward. It appears, therefore, that the least injury from EPTC plus R-25788 occurs when the seed is in a position where it would emerge from the soil most rapidly. Dates suggest that EPTC is primarily taken up by the corn coleoptile (2, 3); then these results indicate that the sooner the coleoptile emerges from the soil surface the less herbicide is taken up and consequently less injury occurs. This correlation is indicated but not proven by these studies.

Corn cultivars were found not to be differentially susceptible to EPTC plus R-25788 at 20 C but were significantly different at 30 C (Table 2). The differential toxicity of the corn cultivars at 30 C was not considered of practical importance in the field with the possible exception of PAG cultivar SX 98. With the exception of PAG cultivar SX 98 the differences in height between the most resistant and the most susceptible corn variety was only 17%. As noted before (1) injury was greater at 30 C than at 20 C. There was, however, no significant interaction between cultivar and temperature. Past studies (4) with thiocarbamate herbicides without R-25788 have found large differences of cultivars and a significant cultivar x temperature interaction. It appears, therefore, that R-25788 changes the response of corn to EPTC in a qualitative as well as a quantitative manner.

Summary

Corn was injured more by EPTC plus R-25788 when the seed was sown at 4 than at 2 cm deep and was injured more when the coleoptile was pointed downward than when it was pointed upward. Cultivars were differentially susceptible to EPTC plus R-25788 at 30 C but not at 20 C.

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Table 1. Influence of depth and position of corn seed on EPTC (112 ppm) Plus R-25788 Injury.

Direction of Coleoptile	Depth of Planting (cm)	Corn Injury (% of Control)
Upward	4	5.4 e*
Horizontal (anterior facing upward)	4	8.9 d
Horizontal (anterior facing downward)	4	0.6 f
Downward	4	0.4 f
Upward	2	31.4 b
Horizontal (anterior facing upward)	2	37.2 a
Horizontal (anterior facing downward)	2	2.6 f
Downward	2	16.3 c

*Values in the same row having a common letter are not significantly different at the 5% level according to the Student-Newman-Keul's test.

Table 2. Influence of corn cultivars on EPTC (99 ppm) plus %-25788 injury to corn.

Source	Cultivar	Corn Injury (% of Control) 20 C	30 C
Dekalb	XL 64	68 a	46 bcd
Dekalb	XL 42	67 a	41 cd
P. A. G.	SX 98	73 a	62 ab
Southern States	750	65 a	36 d
Funk G	4646	57 a	39 cd
Todd	M70	65 a	45 cd
Pioneer	3334A	65 a	31 d

*Values having a common letter are not significantly different at the 5% level according to the Student-Newman-Keul's test.

Effect of Soil Incorporation On Corn Injury to EPTC + R-25788

G. W. Burt
Department of Agronomy

Purpose and Objectives

Reports of corn injury in the field with thiocarbamate herbicides are numerous and little is known about the factors affecting the occurance and severity of this injury. The frequency and severity of injury has been reduced but not eliminated by the addition of R-25788 (N,N-diallyl-2,2-dichloroacetamide). Increases in toxicity of EPTC plus R-25788 to corn seedlings could result from localized accumulations in the soil caused by poor incorporation. The following experiment was conducted to determine the importance of soil incorporation of EPTC plus R-25788 injury to corn.

Procedures

The soil was a silt loam with a pH of 6.5 an organic matter content of 0.7%, with medium phosphate and potassium (1). This soil was mixed with one third vermiculite by volume and was used to fill 26 by 54 by 6 cm flats. These flats were sprayed with a laboratory sprayer (2) applying 280 L/ha of solution which contained the appropriate concentration of EPTC. R-25788 was commercially formulated with EPTC in a ratio of EPTC:R-25788 of 12:1 (w/w). After herbicide application, the soil was transferred to large polyethylene bags and was thoroughly incorporated by shaking or poorly incorporated by turning the bag end over end one time; then the soil was transferred back into the flat. Corn seeds (Pioneer Cultivar 3334A unless otherwise stated) were planted 50 per flat. They were planted 1.5 cm deep with their dent side pointed upward. After planting, the flats were placed in growth chambers at 30 C with a 12 hour photoperiod and 16,000 lux, produced by cool white flourescent lamps supplemented with incadescent bulbs. The height of each

of the 50 plants in each flat were recorded at 10 days after seeding. The coefficient of variation from each treatment was determined by using equation No. 5 on page 137 of Sokal and Rohlf (3). The experiment contained 2 replications of 100 plants for each treatment and the experiment was repeated 4 times.

Results

Mean height of corn was reduced by 28 and 14 ppm of EPTC plus R-25788 (Table 1). This reduction in mean height occurred equally in both well mixed and poorly mixed soil. The means, however, do not reflect the variable toxicity found within each flat. A few plants in each flat were, for example, severely injured in the poorly mixed soil but not in the well mixed soil or the control soil (Table 1). The severe injury of not less than three plants in the poorly mixed soil was not reflected in a reduction of the treatment means but was shown to be statistically significant by comparison of the coefficient of variations of each treatment (Table 1). Plants grown in poorly mixed soils were, therefore, shown to contain more variation than plants grown in well mixed or control soil. Plants immediately adjacent to severely injured plants often appeared entirely uninjured. The percent injury and the extreme variability within each flat were similar to commonly observed field observations. It is assumed, therefore, that the severe injury of a small proportion of plants often located immediately adjacent to normal plants in the field is a result of localized accumulations of herbicide which results from inadequate soil incorporation. The results indicate that even at rates comparable to those used in the field (14 ppm) EPTC plus R-25788 can injure corn if the herbicide is not properly incorporated.

Summary

Poor soil incorporation of EPTC plus R-25788 will result in corn injury.

This is probably a result of localized high accumulations of the herbicide in the soil. Severe injury can result but only to a small (<10%) percentage of the population.

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Table 1. Injury to corn as affected by uniformity of soil incorporation of 14 and 28 ppm of EPTC plus R-25788 in air dry soil.

	Control	well mixed soil 28 ppm EPTC	poorly mixed soil 28 ppm EPTC	poorly mixed soil 14 ppm EPTC
mean (cm)	27.0 a*	23.8 c	23.6 c	24.8 b
mean of 3 shortest plants (cm)	17.2	15.7	14.0	14.9
mean of 3 tallest plants (cm)	31.4	28.4	29.2	30.3
coefficient of variation	13.3 c	12.8 c	18.4 a	15.1 b

*Values in the same row having a common letter are not significantly different at the 5% level according to the Student-Newman-Keul's test.

Temperature and Soil Moisture Effects on Corn Injury Induced by EPTC and Butylate

G. W. Burt
Department of Agronomy

Purpose and Objectives

Thiocarbamate herbicides are used at 3 to 4 lb/A to control many annual and some perennial weeds such as nutsedge. More recently perennial weeds such as johnsongrass have been shown to be susceptible to higher rates of thiocarbamate herbicides (2,4). Injury caused by thiocarbamate herbicides to corn occurs sporadically in the field and is a major hindrance to the wide acceptance of these herbicides. Factors influencing thiocarbamate injury to corn are not well understood. The present study was, therefore, conducted to determine the effect of temperature and soil moisture in EPTC and butylate injury to corn.

Procedures

Flats (26 by 54 by 6 cm) filled with a vermiculite:soil (1:3) mixture were sprayed with a laboratory sprayer (3) at the appropriate herbicide rates with an equivalent of 280 L/ha of solution. The silt loam soil had a pH of 6.5, organic matter of 0.7% with medium potassium and medium phosphorus (1). Immediately after herbicide application to the flats the soil was transferred to polyethylene bags and shaken until the herbicide was thoroughly incorporated. The soil was then transferred to plastic pots (8.4 by 8.4 by 9 cm). The corn seed used was 3369 A from the Pioneer Seed Company which was treated with a fungicide (tertramethyl-thiuramidisulphide). Seeds were planted, 4 per pot, at a depth of 1.5 cm and were positioned with their coleoptiles pointing upward.

Growth chambers were maintained at 30 and 20 C day temperature with 5 C cooler night temperature. Photoperiod was 12 hr with light intensity of 16,000 lux produced by cool white florescent lamps supplemented with incandescent bulbs. The 5 temperature regimes were: a) 30 C continuous, b) 20 C continuous,

c) 30 C for the first 3 days after planting and then transferred to 20 C, d) 20 C for the first 3 days and then transferred to 30 C, 3) 20 C for the first 7 days and then transferred to 30 C. Preliminary trials determined that emergence occurred 3 days after planting at 30 C and 7 days after planting at 20 C.

Preliminary trials determined soil moisture regimes which were as dry and as wet as possible while still permitting adequate growth of corn in control plants at both 20 and 30 C. The dry soil moisture condition was obtained by watering each pot every 48 hr with 25 and 100 ml for the 20 and 30 C treatment, respectively. These procedures resulted in approximately 15% soil moisture 24 hr after water application at both temperatures. Dry treatments are, therefore, referred to as 15% soil moisture treatments. In a similar manner soil moisture was determined to be approximately 33% for the wet treatment 24 hr after watering.

Each experiment was replicated two times. The mean of the four plants per pot was used as a single observation.

Results

High temperatures were shown to increase EPTC and butylate toxicity to corn as indicated by a greater reduction of plant height in continuous 30 C than in continuous 20 C (Table 1). When plants were transferred from 30 to 20 C at the time of emergence (3 days) the mean plant height of all treatments was similar to the continuous 30 C. When transferred from 20 C to 30 C before emergence (3 days) plants were also severely injured. When transferred from 20 C to 30 C at emergence (7 days), however, injury was generally intermediate between the continuous 20 and the continuous 30 C treatments. Injury was, therefore, equal to the continuous 30 C if the plants were subjected to 30 C before, but not after, coleoptile emergence.

The effect of soil moisture on thiocarbamate injury was highly dependent upon temperature (Table 1). There was a significant soil moixture X

temperature interaction. At a continuous 30 C corn injury was greater in 33% than in 15% soil moisture except at the low rate of butylate. At 20 C, however, injury in 33% soil moisture was less than injury in 15% soil moisture with the exception of butylate at the low rate. Treatments subjected to 30 C before emergence (30-20 C 3 days and 20-30 C 3 days) reacted to soil moisture as the continuous 30 C and were more injured in soil with 33% soil moisture compared to 15% soil moisture. The treatment receiving only 20 C before emergence (20-30 C 7 days) and then transferred to 30 C reacted to soil moisture as the continuous 20 C and was injured in 33% soil moisture less than in 15% soil moisture with the exception of butylate at the low rate. The period most sensitive to temperature and soil moisture effects on thiocarbamate injury, is, therefore, before coleoptile emergence.

Summary

EPTC was more toxic to corn than butylate. Increases in temperatures before emergence of the coleoptile increased injury. Soil moisture had little effect on thiocarbamate injury to corn.

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Table 1. The influence of temperature and soil moisture on EPTC and butylate injury to corn.

Herbicide	Rate (ppm)	Soil moisture (%)	Corn height: Day temperature regimes: 30 C continuous (% of control)	20 C continuous (% of control)	30-20 C 3 days (% of control)	20-30 C 3 days (% of control)	20-30 C 7 days (% of control)	Means of Rows
EPTC	6	15	16.7	41.7	35.9	22.4	30.9	29.5 c*
EPTC	6	33	0	69.7	0	36.3	40.9	29.4 c
EPTC	18	15	7.4	15.7	13.4	2.9	13.6	10.6 d
EPTC	18	33	6.4	41.1	0	0	16.4	12.8 d
butylate	19	15	43.9	97.1	67.2	45.4	71.8	65.1 a
butylate	19	33	62.8	90.8	0	26.3	60.5	48.1 b
butylate	50	15	29.3	51.3	46.5	12.4	31.8	34.3 c
butylate	50	33	15.6	64.4	18.1	24.1	35.6	31.6 c
		means of columns	22.8 c*	59.0 a	22.6 c	21.2 c	37.7 b	

*Values having a common letter are not significantly different at the 5% level according to the Student-Newman-Keul's test. Statistical comparisons are not valid between row and column means.

[a]Days designate the time in the first day temperature. Plants were transferred to the second temperature for the remainder of the experimental period.

Temperature and Soil Moisture Effects on Corn Injury Induced by EPTC plus R-25788 and butylate plus R-25788

G. W. Burt
Department of Agronomy

Purpose and Objectives

The factors influencing the degree of thiocarbamate injury to corn are not well understood. Increases in temperature and soil moisture can decrease the toxicity of thiocarbamates applied to the soil surface as a result of greater loss through volatilization (6, 7). Once incorporated into the soil, however, thiocarbamates may cause more injury to corn under cold and wet or hot and dry conditions. Recently, protectants such as R-25788 (N,N-diallyl-2,2-dichloroacetamide) have been mixed with thiocarbamate herbicides (3,4,5). These protectants reduce, but do not eliminate the occurance of thiocarbamate injury to corn. The objectives of the present study was to determine the influence of temperature and soil moisture on corn injury induced by thiocarbamates mixed with R-25788.

Procedures

Flats (26 by 54 by 6 cm) filled with a vermiculite:soil (1:3) mixture were sprayed with a laboratory sprayer (8) at the appropriate herbicide rates with an equivalent of 280 L/ha of solution. The ratio of EPTC:R-25788 was 12:1 (w/w) and the ratio of butylate:R-25788 was 24:1 (w/w). The silt loam soil used had a pH of 6.5, organic matter of 0.7% with medium potassium and medium phosphorus (1). Immediately after herbicide application to the flats the soil was transferred to polyethylene bags and shaken until the herbicide was thoroughly incorporated. The soil was then transferred to plastic pots (8.4 by 8.4 by 9 cm). The corn seed used was 3369A from the Pioneer Seed Company which was treated with a fungicide (tertramethyl-thiuramidisulphide).

Seeds were planted, 4 per pot, at a depth of 1.5 cm and were positioned with their coleoptiles pointing upwards.

Growth chambers were maintained at 30 and 20 C day temperature with 5 C cooler night temperature. Photoperiod was 12 hr with light intensity of 16,000 lux produced by cool white florescent lamps supplemented with incandescent bulbs. The 5 temperature regimes were: a) 30 C continuous, b) 20 C continuous, c) 30 C for the first 3 days after planting and then transferred to 20 C, d) 20 C for the first 3 days and then transferred to 30 C, e) 20 C for the first 7 days and then transferred to 30 C. Preliminary trials determined that emergence occurred 3 days after planting at 30 C and 7 days after planting at 20 C.

Preliminary trials determined soil moisture regimes which were as dry and as wet as possible while still permitting adequate growth of corn in control plants at both 20 and 30 C. The dry soil moisture condition was obtained by watering each pot every 48 hr with 25 and 100 ml for the 20 and 30 C treatment, respectively. These procedures resulted in approximately 15% soil moisture 24 hr after water application at both temperatures. Dry treatments are, therefore, referred to as 15% soil moisture treatments. In a similar manner soil moisture was determined to be approximately 33% for the wet treatment 24 hr after watering.

Each experiment was replicated two times. The mean of the four plants per pot was used as a single observation.

Results

The addition of R-25788 required a 4 to 10 fold increase in the rate of butylate and EPTC to cause comparable injury symptoms to those treatments without protectant (Table 1,2). In addition R-25788 reduced the influence of temperature and soil moisture on thiocarbamate injury (2, Table 1). More injury did not occur at continuous 30 than at continuous 20 C (Table 1) and the influence of transferring plants between the two different temperatures

did not follow the patterns of the herbicides without R-25788 (2). There was also a nonsignificant temperature X soil moisture interaction when R-25788 was added to these two herbicides (Table 1). R-25788, therefore, not only reduces the toxicity of EPTC and butylate to corn but also reduces the influence of temperature and soil moisture on this injury.

Summary

Addition of R-25788 (a protectant) to EPTC and butylate greatly increased the concentration of herbicide required to injure corn. R-25788 greatly diminished the effect of both temperature and soil moisture on thiocarbamate injury.

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Table 1. The influence of temperature and soil moisture on EPTC plus R-25788 and butylate plus R-25788 injury to corn.

Herbicide	Rate (ppm)	Soil moisture (%)	Corn height: Day temperature regimes — 30 C continuous (% of control)	20 C continuous (% of control)	30-20 C 3 days (% of control)	20-30C 3 days (% of control)	20-30 C 7 days (% of control)	Means of Rows
EPTC + R-25788	64+5.1	15	61.5	58.9	48.6	45.3	38.7	50.6 b*
EPTC + R-25788	62+5.1	33	71.9	74.3	59.2	62.8	56.0	64.8 a
EPTC + R-25788	112+10.7	15	16.7	33.7	27.9	21.8	25.4	25.1 c
EPTC + R-25788	112+10.7	33	10.2	35.5	34.1	15.8	23.9	23.9 c
butylate + R-25788	112+4.8	15	63.6	73.7	74.3	63.8	56.7	66.4 a
butylate + R-25788	112+4.8	33	62.6	52.0	77.7	64.7	41.3	60.0 ab
butylate + R-25788	177+7.2	15	58.9	44.3	69.9	39.5	51.1	52.7 b
butylate + R-25788	177+7.2	33	50.6	53.3	66.3	39.4	38.3	49.6 b
	Means of columns		49.5 ab*	53.2 a	57.3 a	44.1 b	41.5 b	

*Values having a common letter are not significantly different at the 5% level according to the Student-Newman-Keul's test. Statistical comparisons are not valid between row and column means.

[a]Days designate the time in the first day temperature. Plants were transferred to the second temperature for the remainder of the experimental period.

Comparison of Johnsongrass Control in Corn and Soybeans

G. W. Burt
Department of Agronomy

Purpose and Objectives

Past research in this Department (2, 3, 4, 5) and elsewhere (6, 7) has shown that thiocarbamate herbicides will control johnsongrass in corn and dinitroaniline herbicides will control johnsongrass in soybeans. Presently the University of Maryland recommends the dinitroaniline herbicides for controlling established johnsongrass but does not recommend the thiocarbamate herbicides. The present study was conducted, therefore, to determine the relative effectiveness on johnsongrass control of EPTC plus R-25788 (a thiocarbamate) in corn compared to trifluralin (a dinitroaniline) in soybeans.

Procedures

The experimental site was partially infested with johnsongrass and was seeded to johnsongrass in the summer of 1971. This area was uniformly and heavily infested with johnsongrass rhizomes in the spring of 1974 when the experiment was initiated. The soil was a Galestown loamy sand with a very low magnesium, high phosphate and medium potash with 0.9% organic matter (1). Plots were 15 by 30 feet with 30 inch row spacing and were replicated three times in a randomized complete block design. Herbicides were applied on May 16, 1974 at 30 gallons per acre and immediately incorporated to a depth of three inches with a rotovator. On the same day corn (Dekalb cultivar XL 43) or soybeans (cultivar York) were planted in appropriate plots (Table 1). Visual ratings were recorded throughout the growth period and yields were recorded from 16 feet of the two center rows on December 10, 1974.

Results

Control of johnsongrass was satisfactory at all rates of EPTC plus R-25788 at the beginning of the season and decreased to 45% control which was unsatisfactory only at the lowest rate used (Table 1). In contrast trifluralin gave satisfactory control only at the highest rate and even at the highest rate satsifactory control occurred only in the beginning of the season.

Crop injury in the early stages of growth was noted only in soybeans. At the highest rate of trifluralin used in this study injury was severe (46%) in the spring and was still unsatisfactory in mid season and appeared to reduce yields (Table 1). Corn showed very little typical thiocarbamate injury symptoms in early July. At this time, however, another malady was affecting the corn. Soil tests revealed that acute manganese deficiency was the most probable cause of corn stunting. Foliar application of manganese in mid July did reverse what appeared to be manganese deficiency in soybeans but did not help corn growth. The lack of corn response to manganese could have been because the corn deficiency had progressed to far to be reversed at this late date. Because of the severe manganese deficiency in corn, further estimation of corn injury was not possible, and corn yields were not taken.

Summary

Johnsongrass was controlled adequately in corn at 6 and 9 lb/A of EPTC plus R-25788. Control lasted throughout the growth season and no corn injury was noted. Johnsongrass was not controlled satisfactory in soybeans at the two lower rates of trifluralin; only early control of johnsongrass resulted with 1.5 lb/A trifluralin. The highest rates of trifluralin severely injured soybeans throughout the season. From one year's data, therefore, thiocarbamate herbicides in corn appear to be superior to dinitroaniline

herbicides in soybeans with respect to both johnsongrass control and crop injury.

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Table 1. Comparison of johnsongrass control with EPTC plus R-25788 in corn and trifluralin in soybeans in 1974.

Herbicide Treatment	Rate (lb/A)	Crop	Johnsongrass Control		Crop Injury		Yield (Bu/A)[a]
			June 4 (%)	July 2 (%)	June 4 (%)	July 2 (%)	
Control (Handweeded)	----	Corn	2 f	78 ab	2 d	22 ab	----
Control (Weedy)	----	Corn	27 e	17 b	2 d	13 ab	----
EPTC plus R-25788	3	Corn	86 b	45 ab	1 d	2 b	----
EPTC plus R-25788	6	Corn	94 ab	87 a	3 cd	3 b	----
EPTC plus R-25788	9	Corn	98 a	90 a	8 c	5 b	----
Control (Handweeded)	----	Soybeans	15 e	78 ab	8 c	20 ab	24.3 a
Control (Weedy)	----	Soybeans	21 e	28 ab	0 d	1 b	4.6 b
Trifluralin	0.5	Soybeans	42 d	37 ab	3 cd	3 b	8.9 b
Trifluralin	1.0	Soybeans	69 c	53 ab	14 b	8 ab	13.1 b
Trifluralin	1.5	Soybeans	80 bc	62 ab	46 a	33 a	11.6 b

[a]No yields of corn were recorded because of severe manganese deficiency. Values in the same column having a common letter are not significantly different at the 5% level according to the Student-Newman-Keul's test.

The Use of Organic Preservatives on Aerobically Stored High Moisture Forage

C. C. Sheaffer and N. A. Clark
Department of Agronomy

Purpose and Objectives

Last year 251,000 acres in Maryland were harvested for hay. In terms of acreage, this is the third largest crop in the state. But in Maryland and the rest of the Northeast, haymaking is one of the most risky agricultural activities. A substantial amount of the hay is ruined before it is ready for baling. Long term weather records show there is a 95 percent probability that only three periods will occur in May with three or more consecutive rain-free days suitable for drying hay. If the normal three-day drying period could be reduced to two days, four drying periods could be expected in May according to these data. This is a 33 percent increase in the probability of effective drying periods. Preliminary work (Sheaffer, C. C. 1974. The evaluation of organic acids as preservatives for stored forages. M.S. Thesis, University of Maryland) has shown that both propionic acid and ammonium isobutyrate are equally effective in preserving high moisture hay when the preservative is uniformly and carefully applied using manually operated equipment. The objective of this study was to evaluate the effectiveness of ammonium isobutyrate (AIB) when it is field-applied on large batches of hay.

Procedure

A New Holland baler was equipped with a large fiberglass tank and a sprayer pump. Four spray nozzles were mounted at the pickup mechanism of the baler. Two of the nozzles were positioned to spray downward on the hay as it was lifted by the pickup unit and the other two nozzles were placed to spray upward, thus directing the AIB to the underside of the windrow just before it entered the bale chamber. The spray pattern was adjusted by using a purple dye and inspecting the sprayed bales for uniformity of coverage. Approximately

ten acres of alfalfa hay were cut on August 18, allowed to dry to 33 percent moisture, and raked into windrows. Three levels of AIB were applied at the baler: 0, 2, and 3 percent by weight of the hay at baling time. On August 20, the hay was stacked in the barn according to treatment, and thermocouples were inserted in bales of all three treatments. Temperatures were monitored unitl September 6, 1974.

Results

The temperature data are shown in Table 1. In previous work, temperature and visable symptoms of mold growth were found to be highly correlated. Mold was also present in the untreated hay in this study, although temperatures in the untreated bales did not reach the levels attained in previous work. The hay is being fed to dairy steers to evaluate its feeding value.

Summary

Ammonium isobutyrate is an effective hay preservative, and this material can be applied in the field at time of baling. A workable system is one in which four nozzles are mounted at the pickup unit on the baler, two above the hay and two below. With this system, the hay receives adequate coverage to successfully preserve it.

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The germ plasm with anthracnose resistance from the Beltsville breeding program ranked in the top places in all tests. However, the data show few statistically significant differences between entries. From visual observation of the plots, it appears that greater differences will be observed in the next two to three years as the persistence of the entries begins to manifest itself.

Summary

Alfalfa strain and variety tests show that anthracnose resistant lines are among the top performers both at the Forage Research Farm and at the Wye Institute. There are indications that these lines will have greater persistence than many of the older varieties in the tests.

Table 1. 1974 dry matter yields from four harvests -- 1971 alfalfa strain and variety test at Clarksville, Maryland.

Alfalfa Entry	Seasonal Yield 1/ (T/A)
MSHp6FAn3W3	6.78 a
MSHp6FAn4W4	6.74 a
KO-2	6.29 ab
MSHp6FAn2W2	6.15 abc
Exp. 309	6.09 abc
ARS-2	6.08 abc
Weevlchek	6.01 abc
Team	5.99 abc
K9-100	5.89 abc
WL 305	5.87 abc
MSB-CW5	5.84 abc
MSB-CW5An3	5.74 bc
Saranac	5.73 bc
Cherokee	5.68 bc
Kanza	5.61 bc
KO-8	5.59 bc
Buffalo	5.53 bc
Williamsburg	5.36 bc
N6-614	5.26 c
Vernal	5.21 c

1/ Any two means which are not followed by the same letter are significantly different at the 5% level. Duncan's Multiple Range Test.

Table 2. 1974 dry matter yields from four harvests -- 1972 alfalfa strain and variety test at Wye Institute, Maryland.

Alfalfa Entry	Seasonal Yield 1/ (T/A)
Beltsville 3-An4	6.03 a
Beltsville 71	5.91 ab
6FAn4W4Sb2W2	5.88 ab
Team	5.71 abc
Beltsville 2An4	5.63 abc
Cherokee	5.60 abc
Weevlchek	5.56 abc
WL 305	5.54 abc
Dominor	5.50 abc
WL 307	5.38 abc
Pioneer 520	5.37 abc
DeKalb 123	5.32 abc
Saranac	5.32 abc
Vernal	5.31 abc
WL 306	5.31 abc
Iroquois	5.30 abc
Beltsville 1-An4	5.25 bc
Promer	5.17 bc
Pioneer 530	5.16 bc
Glacier	5.16 bc
DeKalb 153	5.14 bc
Williamsburg	4.96 c

1/ Any two means which are not followed by the same letter are significantly different at the 5% level. Duncan's Multiple Range Test.

Table 3. 1974 dry matter yields from four harvests -- 1973 alfalfa strain and variety test at Clarksville, Maryland.

Alfalfa Entry	Seasonal Yield 1/ (T/A)
Beltsville MP2	6.7 a
Beltsville 2-An4	6.6 a
Beltsville 71 FC 40851	6.5 ab
Appalachee Phyto 2	6.5 ab
D 69	6.5 ab
Beltsville 72	6.4 ab
NCW 20a	6.4 ab
NCW 20b	6.4 ab
Beltsville 71 FC 40891	6.3 ab
NCW 18b	6.3 ab
MSHp6FAn4W4Sb2W2	6.2 abc
Team	6.2 abc
Beltsville 1-An4	6.2 abc
Glacier	6.1 abc
Williamsburg	6.1 abc
Appalachee	6.1 abc
Weevlchek	6.1 abc
WL 311	6.1 abc
Saranac	6.0 abc
Beltsville 3-An4	5.9 bcd
Vernal	5.8 bcd
WL 305	5.8 bcd
Thor	5.6 cd
N K Spredor	5.0 e

1/ Any two means which are not followed by the same letter are significantly different at the 5% level. Duncan's Multiple Range Test.

Table 4. 1974 dry matter yields from four harvests -- 1973 alfalfa strain and variety test at Wye Institute, Maryland.

Alfalfa Entry	Seasonal Yield 1/ (T/A)
D 69	4.38 a
Beltsville 72	4.36 a
T3X-206	4.13 ab
Beltsville 71	4.12 ab
K1-5	3.98 abc
K3-7	3.92 abcd
WL 311	3.92 abcd
T4X-201	3.90 abcd
JE-1	3.88 abcd
WL 219	3.88 abcd
JG-1	3.87 bcd
Nugget	3.80 bcd
131	3.78 bcd
Agate	3.73 bcd
Iroquois	3.72 bcd
Vernal	3.72 bcd
T3X-262	3.68 bcd
SYN-L	3.67 bcd
N7-5	3.60 cd
Weevlchek	3.58 cd
Saranac	3.49 cd
RP-103	3.44 d

1/ Any two means which are not followed by the same letter are significantly different at the 5% level. Duncan's Multiple Range Test.

Minimum Tillage Establishment of Forage Species

A. M. Decker and R. F. Dudley
Department of Agronomy and U.S.D.A.

Purpose and Objectives

There are thousands of acres of permanent pastures in Maryland located on land too steep for regular soil tillage operations necessary for complete pasture renovation. In order to improve the production and forage quality of these pastures without large-scale soil erosion problems, sod-seeding (minimum tillage) renovation appears to be the answer.

A number of studies have demonstrated the feasibility of sod-seeding renovations, but the effects of different tillage and seeding units, forage species, and herbicides have not been adequately studied.

Five different soil tillage and seeding units were evaluated using five forage species and two herbicides. The first experiment was designed to test different soil openers and seed placement units, two herbicides, and three legumes; the second study evaluated herbicide rate with the same three legumes using one soil tillage and seed placement unit; the third study compared the zip seeder (a commercially available seeder) with the wide flute-disk seed placement unit where two herbicides were applied either banded or broadcast. Soil type for all three experiments was a Chillum silt loam with a pH of 6.5 and medium levels of P and K. The area was uniformly fertilized with 400 pounds of 0-20-20.

Procedure

Experiment I. The basic John Deere Grassland Drill using paraquat banded over the row at seeding was compared with (1) that same seeder equipped with a concave disk to remove a 4-inch strip of sod just prior to seeding, (2) a wide flute soil opener - double disk seeder, (3) a narrow flute - double disk seeder, (4) a deep ripple - double disk seeder, and (5) the wide flute with only the presswheel to place the seed. Paraquat (0.5 lbs/acre)

and glyphosate (1.5 lbs/acre) herbicides were used to control sod growth. Red clover, trefoil, and crownvetch were seeded with the above units.

The experimental design was a randomized complete block design with four replications. The sod was primarily Kentucky bluegrass and timothy.

Experiment II. Three species (red clover, trefoil, and crownvetch) were sod seeded into the bluegrass-timothy sod where paraquat was applied in a 4-inch band over the row at seeding at 0.25, 0.50, and 1.0 pounds per acre. The experiment was a randomized complete block design with four replications.

Experiment III. The wide flute - double disk seed placement unit of Experiment I was compared to the zip seeder. Paraquat at 0.5 pounds per acre was compared with glyphosate at 1.5 pounds per acre. These herbicides were applied in bands over the seeded row and broadcast over the entire plot. The establishment of five species was evaluated in a randomized complete block design with four replications.

Data collected on all three experiments included the degree of initial sod kill, stand establishment, and fall forage yields (seeded species, weeds, and total).

Results

The results to date for Experiment I are shown in Table 1. Sod kill was consistantly more complete and long-lasting with glyphosate than with paraquat even though the reaction time was slower. Stands of red clover were consistantly better than stands of trefoil or crownvetch. There was little difference between stands obtained with paraquat and glyphosate. Stands were generally best with the wide flute - double disk seed placement unit. The wide flute with only the presswheel gave satisfactory stands even though they were slightly lower than where the disk seed placement unit was used. The wide flute - disk seed placement unit gave higher yields than all other combinations. The degree of weed infestation was similar for all treatments. Sod seeding increased total yield, but only in the case of red clover were these increases significant.

The results of Experiment II are given in Table 2. The degree of sod kill increased with the rate of paraquat application; the 0.25 lbs-rate gave inadequate sod control while both of the higher rates appeared adequate. Stand ratings increased with the rate of herbicide; these increases were most pronounced with red clover. The percentage of the sod-seeded species in the total forage yield increased with the degree of sod control. As in Experiment I, there was little difference in weed infestation. Also as in Experiment I, yields were increased with sod seeding, and these differences again were significant only with red clover.

The results of Experiment III are given in Table 3. Again, red clover stands were significantly better than all other species. In the case of red clover, stands were similar for broadcast and banded application of the herbicides; the major difference was that with the banded application there were significantly fewer weeds. In contrast to Experiment I, the paraquat treated plots were better than those treated with glyphosate.

Summary

1. Both paraquat and glyphosate gave adequate sod control for satisfactory establishment of sod-seeded forages.
2. Band application of herbicides resulted in fewer weeds and approximately the same total forage yield.
3. Herbicides were more effective than removing a 4-inch band of sod at seeding in terms of improved seedling establishment, forage yields, and leaving the field less subject to erosion.
4. The wide flute tillage - double disk seed placement combination consistantly resulted in better stands and forage yields.
5. The zip seeder, while not the best, gave excellent seedling stands and forage yields.

Table 1. Effects of several soil tillage and seed placement units, two herbicides, and three sod-seeded legumes on the degree of sod kill, seedling establishment, and forage yield of treated pasture swards, 1974.

Treatment [1]	Sod Kill Rating [2]	Stand Rating of Seeded Species [3]		Dry Matter Yields (T/A) [4]		
	5-7	6-27	8-5	Seeded Species	Weeds	Total
Check	-	-	-	-	.08 a	.70 a
C-S-CV	5.0	1.5	1.5	.04 d	.09 a	.74 g
C-S-RC	5.0	2.2	2.2	.35 c	.04 a	.96 c-f
C-S-TR	5.0	2.0	1.8	.04 d	.08 a	.71 g
ST-S-CV-P	3.0	1.2	1.2	.01 d	.12 a	.86 d-g
ST-S-RC-P	2.8	2.5	2.2	.30 c	.10 a	1.02 b-c
ST-S-TR-P	2.5	1.0	1.2	.05 d	.08 a	.82 fg
W-D-CV-P	3.0	1.8	1.8	.02 d	.09 a	.86 d-g
W-D-RC-P	2.0	3.2	4.0	.49 a	.08 a	1.26 a
W-D-TR-P	2.8	1.2	1.0	.03 d	.10 a	.86 d-g
W-D-CV-G	4.2	1.5	1.2	.04 d	.10 a	.85 efg
W-D-RC-G	5.0	4.5	4.8	.48 ab	.10 a	1.20 ab
W-D-TR-G	4.8	1.8	1.0	.04 d	.10 a	.75 g
W-PW-RC-P	3.2	2.2	2.2	.36 c	.05 a	1.09 a-d
N-D-RC-P	2.8	2.0	3.0	.36 c	.10 a	1.10 abc
DR-D-RC-P	2.5	2.5	3.2	.33 c	.07 a	1.05 bcd

1/ C = concave disk, ST = straight disk, W = wide flute, N = narrow flute, DR = deep ripple, PW = presswheel only, S = spear seeder, D = disk seeder; RC = red clover, CV = crownvetch, TR = trefoil; P = paraquat, G = glyphosate

2/ Degree of sod kill within treated band (0 = no kill; 5 = maximum kill)

3/ Ground cover and plant vigor rating (1 = worst; 5 = best)

4/ Any two means which are not followed by the same letter are significantly different at the 5% level. Duncan's Multiple Range Test.

Table 2. Effects of three paraquat rates on the degree of sod kill, seedling establishment, and forage yields of three sod-seeded legumes, 1974.

Treatment [1]	Sod Kill Rating [2] 5-7	Stand Rating of Seeded Species [3] 6-27	8-5	Dry Matter Yields (T/A) [4] Seeded Species	Weeds	Total
Check	-	-	-	-	.06	.44 d
RC-LP	1.5	2.2	2.0	.24 b	.03 b	.75 ab
RC-MP	2.2	2.5	3.2	.27 ab	.03 b	.80 a
RC-HP	4.8	3.5	4.0	.32 a	.05 ab	.87 a
Av.	2.8	2.7	3.1	.28 A	.04 B	.81 A
CV-LP	1.0	1.0	1.0	.02 c	.06 ab	.55 cd
CV-MP	2.2	2.2	1.0	.02 c	.06 ab	.58 cd
CV-HP	4.8	1.5	1.0	.02 c	.09 a	.51 cd
Av.	2.7	1.6	1.0	.02 B	.07 B	.55 B
TR-LP	1.0	1.0	1.0	.01 c	.07 ab	.48 cd
TR-MP	2.8	1.5	1.0	.02 c	.06 ab	.61 bc
TR-MP	4.8	1.5	1.2	.04 c	.08 ab	.54 cd
Av.	2.9	1.3	1.1	.02 B	.08 A	.54 B
LPB	1.2	1.4	1.3	.09 Y	.05 X	.59 X
MPB	2.4	2.1	1.7	.10 X	.05 X	.66 X
HPB	4.8	2.2	2.1	.13 X	.07 X	.64 X

1/ RC = red clover, CV = crownvetch, TR = trefoil
LP = paraquat, $\frac{1}{4}$ lb; MP = paraquat, $\frac{1}{2}$ lb; HP = paraquat, 1 lb (paraquat applied in 4 - 6 inch bands)

2/ Degree of sod kill within the band (0 = no kill; 5 = maximum kill)

3/ Ground cover and plant vigor rating (1 = worst; 5 = best)

4/ Any two means which are not followed by the same letter are significantly different at the 5% level. Duncan's Multiple Range Test.

Table 3. Effects of band and broadcast application of two herbicides and the use of two sod-seeding units on the establishment and forage yields of five sod-seeded species, 1974.

Treatments [1]	Stand Rating of Seeded Species [2]		Dry Matter Yields (T/A) [3]		
	6-27	8-5	Seeded Species	Weeds	Total
Check	-	-	-	.06 g	.79 f
WD-PB-RC	3.2	3.5	1.46 a	.09 g	1.57 a
WD-PB-TF	1.0	1.0	.01 g	.79 ab	.81 ef
WD-GB-RC	1.5	1.8	.73 b	.71 abc	1.44 ab
WD-GB-TF	1.5	1.2	.01 g	.82 ab	.84 ef
ZP-GB-RC	1.0	2.0	.68 bc	.55 bcd	1.24 a-d
ZP-GB-TF	1.0	1.0	.01 g	.76 abc	.77 f
ZP-GB-TR	1.8	1.0	.29 def	.50 cde	.78 f
ZP-GB-AL	1.0	1.5	.25 ef	.78 ab	1.06 c-f
ZP-PB-RC	3.0	3.5	1.38 a	.07 g	1.45 ab
ZP-PB-TF	1.2	1.2	.02 g	.88 a	.94 def
ZP-PB-CV	1.2	1.0	.10 f	.71 abc	.81 ef
ZP-PB-AL	2.5	3.2	.45 b-e	.41 def	.87 ef
ZP-P-RC	3.5	3.8	.58 bcd	.03 g	1.39 abc
ZP-P-TF	1.2	1.0	.00 g	.09 g	.91 def
ZP-G-RC	1.2	1.5	.29 def	.27 efg	.87 ef
ZP-G-TF	1.5	1.2	.22 ef	.23 fg	.84 ef

1/ WD = wide flute with disk seeder, ZP = zip seeder;
PB = broadcast paraquat, P = banded paraquat, GB = broadcast glyphosate,
G = banded glyphosate;
RC = red clover, TF = tall fescue, TR = trefoil, AL = alfalfa, CV = crownvetch

2/ Ground cover and plant vigor rating (1 = worst; 5 = best)

3/ Any two means which are not followed by the same letter are significantly different at the 5% level. Duncan's Multiple Range Test.

Effects of Sewage Sludge and Fertilizer Applications on Crop Yields, Soil Nutrient Status, and Soil Structure

A. M. Decker, D. W. Wolf, E. Strickling, R. L. Chaney, and J. M. Walker
Department of Agronomy and BWML, USDA

Purpose and Objectives

Increased environmental awareness by citizens and government is demanding that sewage sludge disposal be done by safe and beneficial procedures. As a result, much sludge may be recycled onto agricultural land. The amounts of sewage sludge which can be safely and profitably applied to agricultural lands are limited by the status of such things as nitrogen, heavy metals, pathogens, the crops to be grown, and the intended use of these crops.

The objectives of this study were: (1) To look at yields of corn and soybeans as affected by rates of sludge applied to field plots; (2) To determine heavy metal uptake of these crops and other crops; and (3) To look at changes in the soil brought about by these sludge applications.

Procedure

In the spring of 1972, digested sludge from Washington, D.C. was applied to a Sassafras silt loam soil at rates of 0, 25, 50, and 100 dry tons per acre. The sludge was applied in strips 140 feet long and 25 feet wide. One half of each strip was planted to corn and the other half to soybeans. Each crop half was divided into three replications, and fertilizer treatments (F_1 = no fertilizer; F_2 = 80 lbs each of P_2O_5 and K_2O plus 160 lbs N on the F_2-zero-sludge plots) were applied at random within each replication during each of the last three years. Because the sludge and crops were arranged in blocks without replication, only interactions with fertilizer rates could be statistically tested.

Yields of a winter rye cover, corn silage, corn grain, and soybeans were determined. Whole plant and seed plant samples were saved for chemical analyses. Soil samples were taken in the fall of 1974 for soil aggregation

determinations. In May, 1974, each plot was again sampled at depths of 0-6, 6-12, 12-24, 24-36, and 36-48 inches and NO_3-N levels determined.

Results

Dry matter yields of the winter cover crop of rye are presented in Table 1. Yields on the soybean plots were generally higher than on the corn plots. There was a significant fertilizer response only on the corn plots with zero sludge. The 25- and 50-ton sludge rates on the corn plots were significantly more productive than the fertilized check but significantly lower than the 100-ton sludge rate. On the soybean plots, the 50- and 100-ton sludge rates were similar but significantly higher than the 25-ton rate.

Yields for corn and soybeans are presented in Table 2. Silage yields were similar for the fertilized check and all three sludge rates; there was a fertilizer response only on the check treatment for both silage and grain yields. Only at the 100-ton sludge rate was there an increase in grain yields. Soybean yields were similar at the zero and 25-ton sludge rates which were significantly lower than yields at the 50- and 100-ton sludge rates.

The nitrate-nitrogen content of soils two years after sludge application are presented in Table 3. Accumulation of nitrate-nitrogen was found at the 100-ton sludge rate, especially between the 24- and 36-inch depths.

The nutrient status of the soil and percent soil aggregation after three years of growing corn and soybeans are shown in Table 4. The pH had dropped on all plots with slightly lower levels on all sludge rates. Sludge application rates markedly increased the phosphorus content in the soil but had little effect on either magnesium or potassium. Soil aggregation was markedly increased with each rate of sludge; these values were generally higher on the soybean cropped plots.

Summary

1. After three years of cropping, yields of corn, soybeans, and a winter rye cover were increased with the application of sewage sludge.

2. Corn grain yields leveled off at 100 tons of sludge, while soybean yields leveled off at 50 tons of sludge.

3. Except for the zero sludge rate, there was no crop response to fertilizer application.

4. Accumulation of nitrate-nitrogen was found at the high sludge application rate.

5. Soil aggregation at the end of the third cropping year was markedly increased by sludge application.

Table 1. Dry matter yields of cereal rye grown during the winter months between fall harvest and spring planting of corn and soybeans. No fertilizer was added to the winter rye crop. 1974.

Sludge dry tons/A	Corn and Soybean Fertilization 1/ lbs/A	Tons Dry Matter Per Acre Corn Plots	Soybean Plots
0	F_1	0.66 i 2/	1.23 gh 2/
	F_2	1.02 h	1.32 fgh
25	F_1	1.62 ef	2.10 d
	F_2	1.65 e	2.01 d
50	F_1	1.44 efg	2.61 bc
	F_2	1.53 efg	2.73 abc
100	F_1	2.49 bc	2.79 ab
	F_2	2.46 c	2.94 a

C.V. = 24.8%

1/ F_1 = no fertilizer applied

F_2 = corn: 160-80-80 on zero and 0-80-80 on 25-, 50-, and 100-ton sludge rates
soybeans: 0-80-80

2/ Values followed by the same letter are from the same statistical population (P = .05).

Table 2. Yield of corn and soybeans as affected by sewage sludge and fertilizer applications. 1974

Treatment		Yields Per Acre		
		Corn		
Sludge T/A	Fertilizer 1/ lbs/A	Silage T/A	Grain Bu/A	Soybeans Bu/A
0	F_1	5.76 b 2/	10.9 e 2/	36.3 b 2/
	F_2	18.73 a	91.8 d	35.7 b
25	F_1	20.53 a	103.0 cd	36.4 b
	F_2	18.46 a	92.0 d	37.6 b
50	F_1	19.40 a	109.5 bc	40.6 a
	F_2	19.44 a	107.0 c	41.0 a
100	F_1	23.00 a	122.0 ab	42.9 a
	F_2	23.00 a	124.5 a	42.7 a
C.V. %		13.4	6.7	3.1

1/ F_1 = no fertilizer applied

F_2 = corn: 160-80-80 on zero sludge, 0-80-80 on 25-, 50-, 100-ton sludge rates
soybeans: 0-80-80

2/ Values in each column followed by the same letter are from the same statistical population (P = .05).

Table 3. Nitrate-nitrogen content (NO_3-N ppm) of soil samples collected in May, 1974.

Soil Depth in.	Tons of Sludge Per Acre 1/							
	0		25		50		100	
	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1
	Corn Plots							
0-6	1.0	1.0	6.6	3.1	3.4	7.7	7.5	5.9
6-12	0.4	0.6	0.4	1.2	1.0	3.0	2.2	2.4
12-24	0.8	2.2	0.5	0.6	1.6	2.5	5.6	8.4
24-36	2.2	2.1	0.7	0.9	2.8	5.4	10.4	13.9
36-48	3.3	1.0	2.1	1.9	4.2	4.3	8.2	12.3
	Soybean Plots							
0-6	1.0	0.9	1.9	8.8	4.1	2.0	1.2	1.0
6-12	1.0	1.7	0.8	0.6	1.4	4.1	3.5	2.0
12-24	1.2	1.1	0.4	0.5	1.1	2.9	7.0	9.8
24-36	1.5	2.0	2.5	1.7	2.9	6.7	11.7	12.3
36-48	3.8	4.4	2.2	2.3	4.3	6.2	9.2	9.6

1/ F_1 = no fertilizer applied

F_2 = corn: 160-80-80 on zero and 0-80-80 on 25-, 50-, and 100-ton sludge rates
soybeans: 0-80-80

Table 4. Effects of sludge applications in 1972 and annual fertilizer applications on pH, magnesium, phosphorus, potassium, and soil aggregation after three years of growing corn and soybeans.

Crop	Sludge T/A	Fertilizer[1/] lbs/A	Soil Samples Collected Spring 1975 pH	Mg	P_2O_5	K_2O	% Soil Aggregation Fall 1974
			------ lbs/A ---------				
Corn	0	F_1	5.6	139	213	191	25.95
		F_2	5.2	90	263	202	16.01
	25	F_1	5.4	114	395	133	29.39
		F_2	5.4	120	462	182	26.72
	50	F_1	5.3	131	750+	134	42.21
		F_2	5.4	121	713	163	40.28
	100	F_1	5.3	143	750+	139	46.23
		F_2	5.3	144	750+	168	47.87
Soybeans	0	F_1	5.9	197	237	190	13.93
		F_2	5.7	177	290	223	14.12
	25	F_1	5.5	150	507	137	33.13
		F_2	5.5	144	643	155	35.18
	50	F_1	5.5	156	750+	124	50.97
		F_2	5.5	164	743	150	47.13
	100	F_1	5.4	183	750+	158	64.22
		F_2	5.5	172	750+	166	64.15

1/ F_1 = no fertilizer applied

F_2 = corn: 160-80-80 on zero and 0-80-80 on 25-, 50-, and 100-ton sludge rates
soybeans: 0-80-80

Zinc Adsorption and Desorption by Two Soils

R. F. Korcak and D. S. Fanning
Department of Agronomy

Purpose and Objectives

The application of sewage sludges to land has brought about many areas of concern. Among these are possible detrimental effects of heavy metals in sludges to crops and to the food chain. The soil cation exchange capacity has been suggested as a gauge of the amount of metals a soil might tolerate before plants show toxicity problems. In order to elucidate some of the unanswered questions pertaining to heavy metal availability to plants a laboratory study was conducted to determine if two soils that differed in CEC would differ in their ability to adsorb and desorb zinc.

The objective of the study was to determine whether two soil materials of differing chemical and physical properties differed in their ability to adsorb and release zinc applied in a salt solution.

Procedures

Eight, one gram, samples of a Sassafras B horizon and of a Fauquier B horizon were equilibrated with 5 ml of a 325 ug/ml solution of zinc for a period of 24 hours in centrifuge tubes. After equilibration all tubes were centrifuged and the supernatent liquid was decanted and analyzed for zinc. The initial zinc concentration minus the zinc concentration of the decantate allowed the zinc adsorbed by the soil to be calculated. The soils were then treated with a suitable aliquot of weak acid extractant (0.05 N HCl plus 0.025 N H_2SO_4) in order to obtain an index of the plant "available" zinc following adsorption. All zinc analyses were performed by atomic adsorption spectrophotometry.

The soils were also characterized according to standard procedures.

Results and Discussion

The characteristics of the soils are given in Table 1. The soils differed in all properties tested, but of prime interest was the much higher cation exchange capacity of the Fauquier soil.

The total amount of zinc adsorbed onto the soils, the amount of weak acid extractable zinc and the percent of the adsorbed zinc extracted are presented in Table 2. As expected, the higher exchange-capacity Fauquier soil adsorbed more zinc, approximately 41% more, than the Sassafras soil. However, the difference in the amount adsorbed was not in proportion to the difference in cation exchange capacity.

The Fauquier soil released more weak acid extractable zinc, reflecting the greater amount of zinc present because of greater adsorption.

Expressed as a percentage of the amount of adsorbed zinc present in the soil, the Fauquier released less Zn -- 38.6% as opposed to 54.4% for the Sassafras (Table 2). This again appeared to reflect the greater cation exchange capacity of the Fauquier soil, since with it more Zn was held in a non-extractable condition. Like the total amount adsorbed, however, the difference in the fraction held non-extractable was not as great as expected based on the difference in CEC.

The zinc adsorbed by the two soils expressed as a percentage of cation exchange sites available (as measured by the calcium exchange capacity) was 13.1% for the Fauquier and 31.5% for the Sassafras.

Summary

The study has shown that small samples can be handled in the laboratory in order to explore the role of various soil factors in the adsorption and subsequent release of heavy metals from soils. The difference between soils not only to adsorb a heavy metal, zinc, but also to release it in a plant "available" form was quite evident. Although the higher exchange capacity soil adsorbed more Zn from solution and released a smaller proportion of that adsorbed to an extractant - these differences were proportionately smaller than the differences between the cation exchange capacity values of the soils. It should be noted that zinc was employed in the experiment as the metal salt compared to the existence in sewage sludges of predominantly organically bound forms of zinc.

Speculating on the basis of this limited evidence, it thus seems possible that higher CEC soils may retain more metals in the zone of application and thus have more to release to growing plants whereas in a low CEC soil more metals might move downward in a leaching environment. Also, higher CEC soils may release a smaller proportion of the amount of a metal present to an extractant and by inference to a plant. However, the differences in adsorption and the release were less than what would have been expected based strictly on the difference in CEC values in this study.

Table 1. Characteristics of the soils employed for the zinc adsorption studies

Soil Type--Horizon	Texture	pH	Organic Matter %	Native Weak Acid Extractable Zinc ppm	Calcium Exchange Capacity* meq/100g
Fauquier-B	Silty Clay Loam	6.1	0.81	0.4	27.5
Sassafras-B	Sandy Loam	5.2	0.35	0.1	6.7

*Cation exchange capacity determined by pH 7 calcium acetate saturation and magnesium acetate replacement.

Table 2. The total amounts of adsorbed zinc (by one gram of soil from 5 ml of 325 ug/ml zinc solution after 24 hours), weak acid extractable zinc following adsorption, and percent of the adsorbed zinc which was extracted from the two soils.

Soil	Total zinc adsorbed by the soil	Weak acid extractable zinc	% of adsorbed zinc extracted
	ug/g soil	ug/g soil	
Fauquier	1175.5* $\pm$ 38.4	441.4 $\pm$ 20.7	37.6 $\pm$ 1.2
Sassafras	689.5 $\pm$ 41.2	378.6 $\pm$ 19.7	55.0 $\pm$ 2.4

* all values are averages of eight replications.

Loess Deposits on the Eastern Shore of Maryland

J.E. Foss, D.S. Fanning, F.P. Miller, and D.P. Wagner
Department of Agronomy

Purpose and Objectives

Over 50% of the soils on the Eastern Shore of Maryland are comprised of soils designated as "silty". The source of the silty mantle has been questioned for many years, and the variable thickness of the silts has also lead to problems in delineation of soil mapping units. This silty deposit has been noted to mantle a variety of formations at various elevations and is generally stone-free, contains 50 to 75% silt-sized particles, and is yellowish brown in color (unweathered). Eolian origin has been suggested for this deposit, but a comprehensive study has not been made on the silty materials. The objectives of this study were to investigate the distribution, characteristics, and genesis of this silty deposit in the upper Eastern Shore of Maryland.

Procedure

Observations of silt thickness were made along a series of east-west traverses and individual borings in Kent, Cecil, and Queen Annes counties. Borings were made on nearly level, interfluve positions where erosion has been minimal. Samples for particle-size analysis were taken just below the Ap horizon; this resulted in sampling either the A2 or B1 horizon. Particle-size analysis was determined by the pipette method.

Results

Figure 1 shows the thickness of the silty mantle in the upper Eastern Shore of Maryland. The silts are thicker near the Chesapeake Bay and thin eastward. The silts in traverse 2 had a maximum thickness of 203 cm (80 inches) near the Bay, and thinned to about 51 cm (20 inches) at a distance of 22.5 km (14 miles) from the Bay. (Figure 2). A correlation coefficient of r= -0.96

indicates a highly significant relationship between silt thickness and distance from the source area which is presumed to be the Chesapeake Bay. During parts of the Pleistocene, sea level was lower and the Susquehanna River probably flowed down the bottom of the present Bay carrying melt water and sediment from glaciers to the north. This probably provided the silts for subsequent deposition by wind on uplands along the Bay.

On the 12-meter (40 feet) elevation terrace in Kent County, silt thickness ranged from 142 cm (56 inches) near the Bay to 119 cm (47 inches) about 7 km (4.7 miles) eastward. At several locations the silt thickness on the higher upland immediately east of this terrace increased to over 230 cm (90 inches) and then decreased eastward to less than 51 cm (20 inches). The environment for deposition of the silts in these upland positions was apparently more favorable as a result of topographic influence on deposition, vegetation effects, or perhaps the higher areas were free from inundation for longer periods during the Pleistocene and thus received more silts. However, weathering zones within the deeper silts have not been found to date.

Figure 2 shows the distribution of total silt, coarse silt, and fine sand with distance from the Chesapeake Bay. With increasing eastward distance from the Bay, the total silt and coarse silt decrease. The fine sands decrease to about 12 km (7.5 miles) and then increase. Particle size analysis indicates mixing of coarser fractions into the silts that are less than 91 cm (36 inches) in thickness. This is similar to the relationships found previously for shallow loess deposits of Connecticut and Indiana.

Dating of the silty deposit was facilitated by locating a buried A horizon of a well-developed paleosol at the base of the silt mantle. A ^{14}C date of 10,520 ± 240 years B.P. was obtained on the organic material of the buried soil. The location of the site is near Newtown, Maryland in Kent County on the 12 meter (40 feet) terrace. Some of the silts may be older than this, but judging

from silt thickness the bulk of the material was probably deposited since this time. Soil development in the loess (e.g. clay accumulation, structure development, thickness of horizons) seems comparable to what would be expected for the date obtained on the buried soil.

Summary

The silt deposits in the upper Eastern Shore of Maryland appear to be loessial in origin. The Chesapeake Bay was the probable source of the wind deposits as evidenced by loess thickness and particle size distribution from the Bay. The silts in the lower Eastern Shore appear to be continuous to the loess in the upper shore, and thus are probably also of eolian origin. A major segment of the loess was deposited during the recession of the last glacial episode; this is based on the ^{14}C date of 10,520 $\pm$ 240 years B.P. on an A horizon of a buried paleosol at the base of the loess. Mixing of local coarse materials during deposition has influenced the particle size distribution of loess less than 91 cm (36 inches) in thickness.

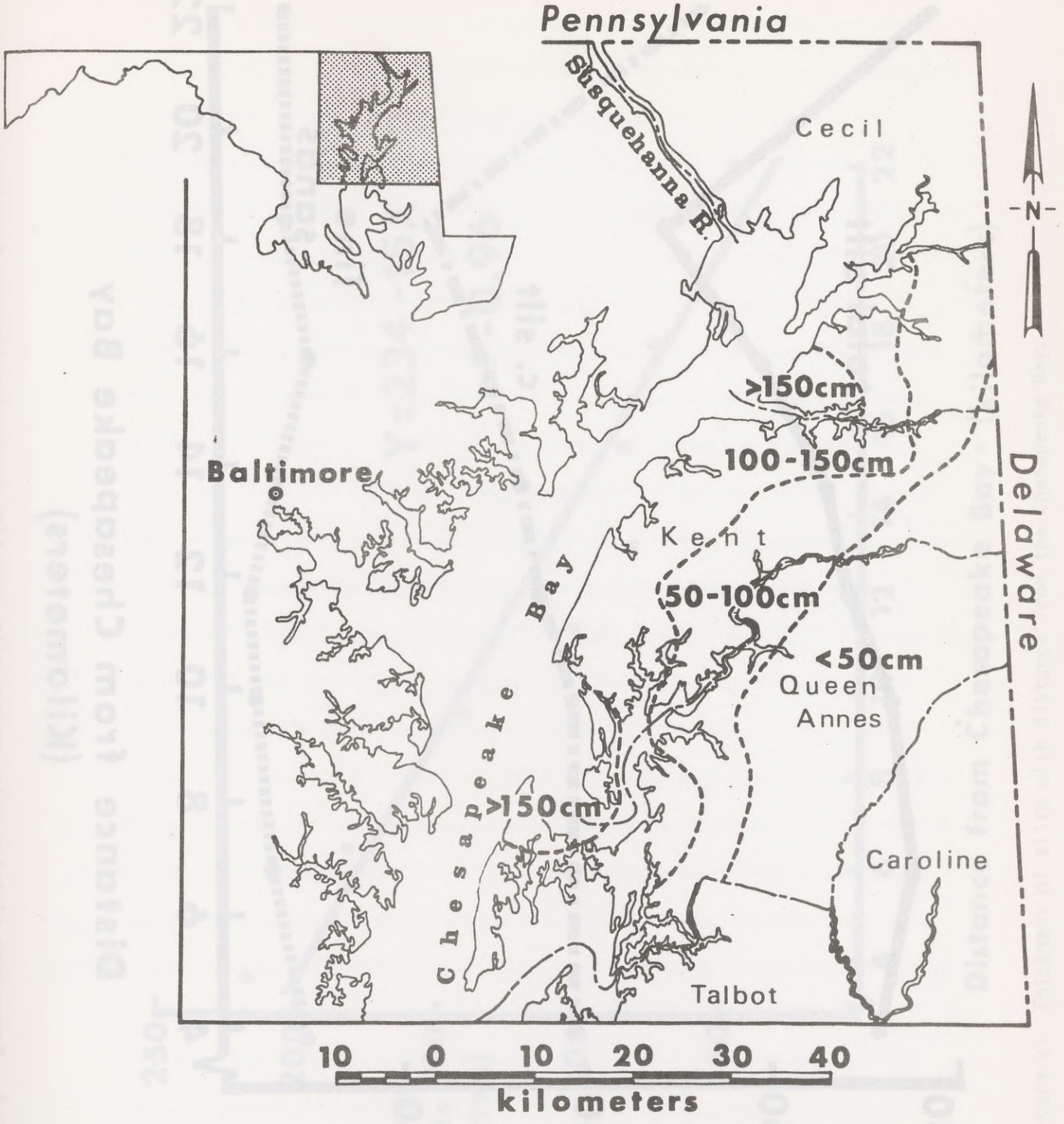

Figure 1. Thickness of silt mantle in the upper Eastern Shore of Maryland.

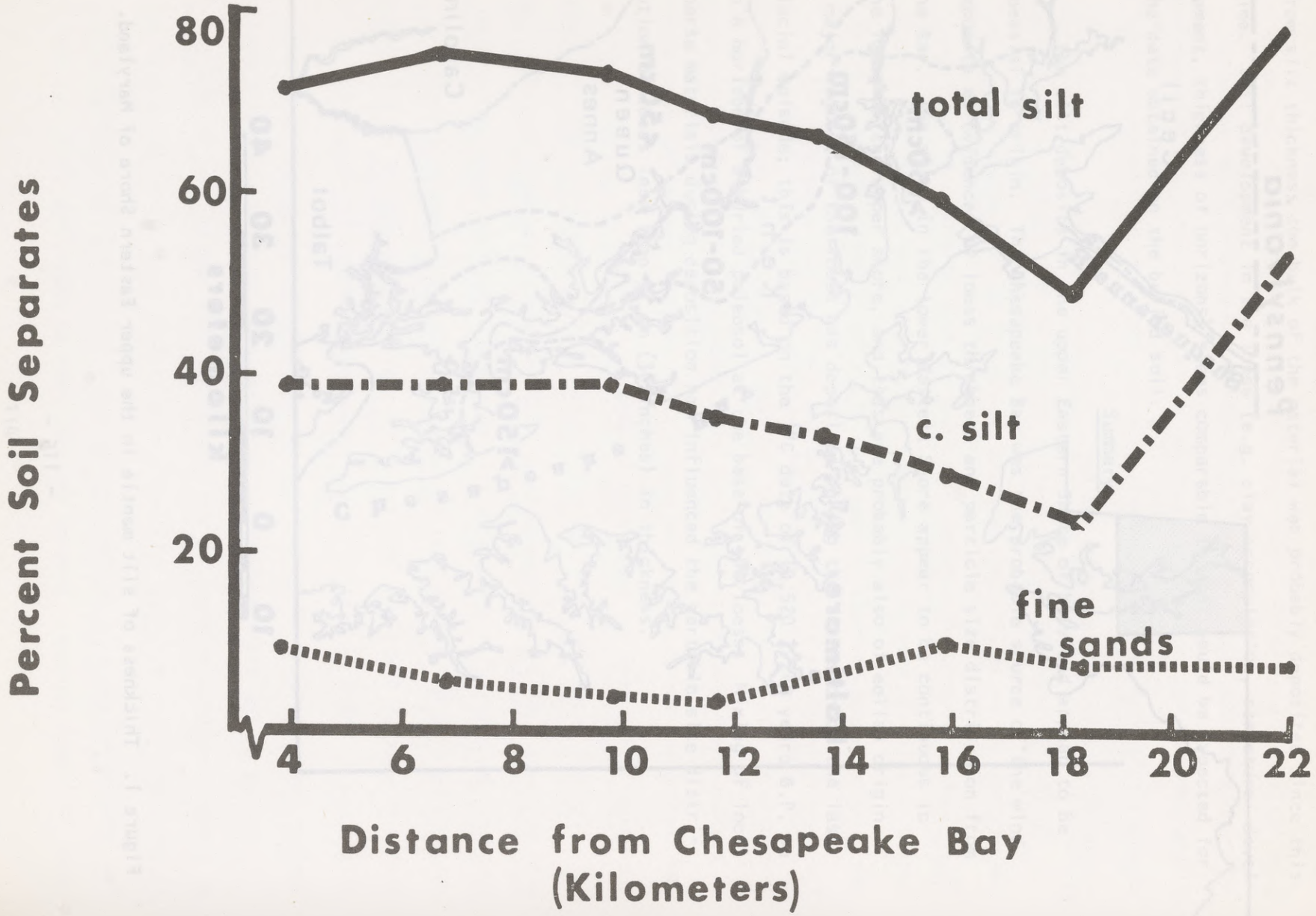

Figure 3. Percentage of total silt, coarse silt, and fine sands with distance from the Chesapeake Bay.

Chesapeake Bay.

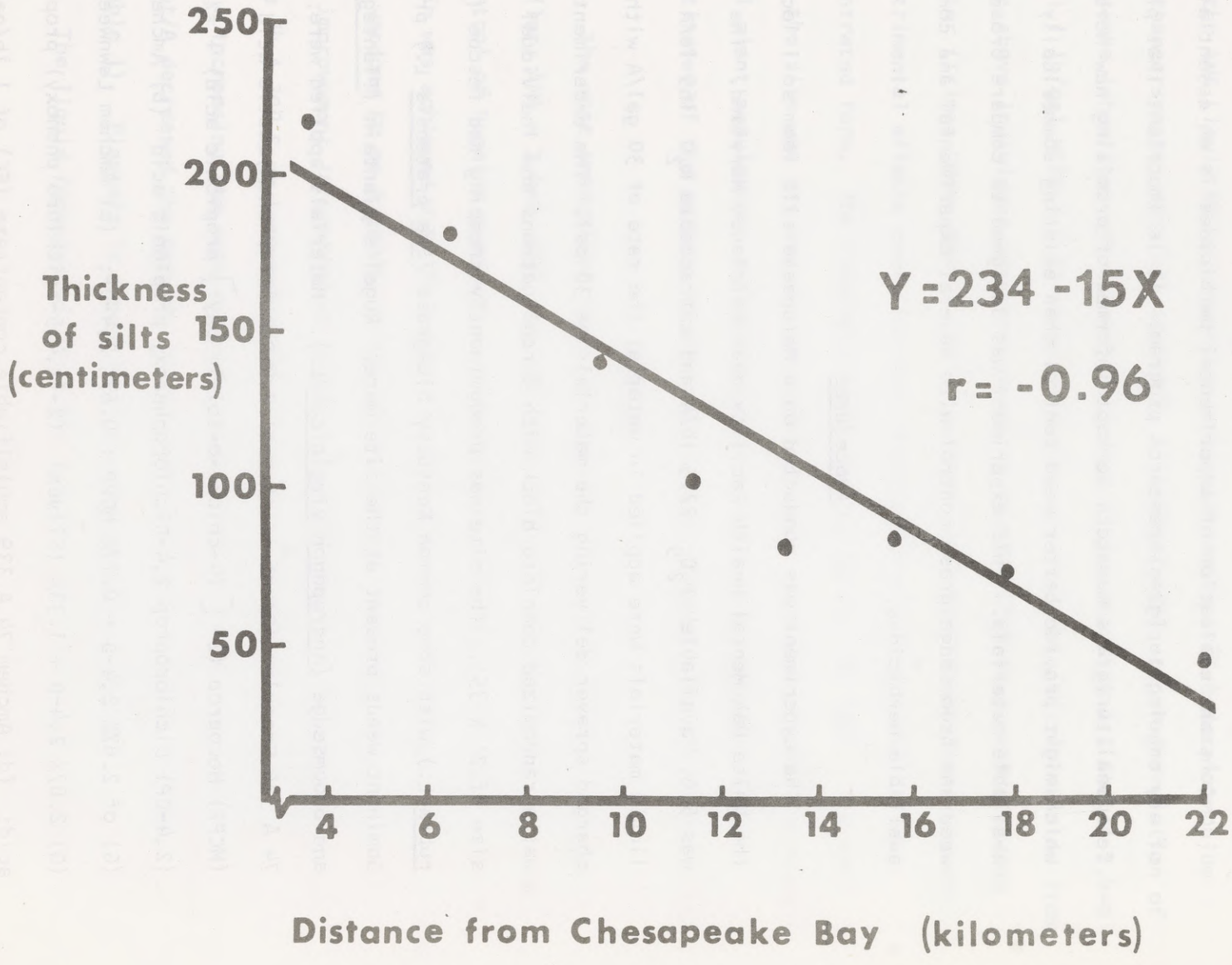

Figure 2. Thickness of silts with distance from the Chesapeake Bay.

Control of Rugel's Plantain and Broomsedge in Turf

John R. Hall

Purpose and Objectives

Constant evaluation of experimental herbicides is an essential part of any ongoing turfgrass research program. It is important that professional turfgrass managers be kept informed of promising new herbicides which might provide better weed control than existing commerically available materials. This experiment was designed to compare broadleaf weed and broomsedge grass control with several experimental and commercially available herbicides.

Procedures

The experiment was conducted on a Matapeake silt loam soil located on the White Oak Mental Health Facility near Fairland, Maryland. The soil pH was 5.6, "available" P_2O_5 22.5 lb/A and extractable K_2O 165 lb/A (1). All liquid materials were applied in water at the rate of 30 gal/A with CO_2 charged sprayer delivering the materials at 30 psi. The experimental design was a randomized complete block with 3 replications and individual plot size of 2' X 35'. The site was predominantly creeping red fescue (Festuca rubra L.) with some common Kentucky bluegrass (Poa pratensis L.) present. Dominant weeds present at the site were: Rugel's plantain (Plantago major L.) and broomsedge (Andropogon virginicus L.). Materials applied were: (a) Amchem 74 A 325 Granular (G) of 1% (2,4-D) 2,4-Dichlorophenoxyacetic acid + $\frac{1}{2}$% (MCPP) Mecoprop (2-[(4-chloro-o-tolyl) oxy] propionic acid) + $\frac{1}{2}$% (2,4-DP) Dichloroprop 2,4-Dichlorophenoxy propionic acid (b) Amchem 74 A 320 (G) of 2.67% 2,4-D + 0.17% MCPP + 0.67% 2,4-DP; (c) Amchem Lawnweed killer (G) 2.67% 2,4-D + 1.33% (Silvex) (2-(2,4,5-trichloro phenoxy) propionic acid; (d) Amchem 74 A 339 emulsifiable concentrate (EC) of 1 lb/gal 2,4-D

+ ½ lb/gal MCPP + ½ lb/gal 2,4-DP; (e) 3D weedone (EC) containing 1 lb/gal 2,4-D + 0.5 lb/gal silvex and 0.125 lb/gal (dicamba) 3.6 dichloro-o-anisic acid; (f) Ortho crabgrass and dandelion killer (AMA) 8% Dodecylammonium methanearsonate + 8% octylammonium methanearsonate + 8.16% 2,4-D; (g) Ortho AMA Liquid 8% octylammonium methanearsonate + 8% Dodecylammonium methanearsonate; Velsicol VEL 4207, a 2 lb/gal (EC), ester formulation of dicamba (chemistry not released); Trimec (EC) containing 2.2 lb/gal 2,4-D + 1.1 lb/gal MCPP + 0.22 lb/gal dicamba; and a Trimec (EC) formulated from the above individual materials mixed in concentrated form before adding water (Trimec "Home Mix"). This treatment was added to determine if any detrimental effects prevailed when these materials were mixed in concentrated form. The treatments were applied on May 10, 1974. The soil at the site was dry and air temperatures were approximately 90° Fahrenheit, All plant populations are expressed as percent cover and are visual estimates of the percent of the plot surface covered with the plant noted.

Results

The most predominant weed was Rugel's plantain (Table 1). Lawnweed killer, AMA + 2,4-D, AMA, and VEL 4207 (Dicamba) did not provide adequate control of Rugel's plantain. Exceptionally good control of Rugel's plantain was achieved with 74 A 325 G at 200 lb/A, 74 A 339 EC at 1 and 2 gal/A, 3D weedone ED at 2 gal/A, Trimec EC and Trimec "Home Mix" EC at ½ gal/A. No improvement in control of Rugel's plantain was achieved by increasing the 74 A 320 G or Lawnweed killer G application from 71 to 142 lb/A.

Increasing the rate of application of VEL 4207 EC from 1 pt/A to 2 pt/A decreased the percent of the plot in Rugel's plantain by 17% (Table 1). Plantain is noted for its resistance to dicamba.

The liquid formulation (74 A 339 EC) of 2,4-D, MCPP and 2,4-DP

provided faster and more complete Rugel's plantain control (Table 1) than the granular formulation 74 A 325 G containing the same materials. The 3D-weedone formulation containing 2,4-D, Silvex and Dicamba did not provide complete control of the plantain at the 1 gal/A rate.

There was no difference between commercially formulated trimec and the trimec "Home Mix" indicating there is no loss of activity resulting from mixing the concentrated materials before spraying.

As was expected, the only materials providing acceptable control of Broomsedge were AMA + 2,4-D and AMA alone (Table 2). As the pressure from the broadleaf weeds was released the Kentucky bluegrass and creeping red fescue began to dominate the plots. The only treatments that visibly damaged the grasses present were 74 A 339 EC at 2 gal/A and 3D weedone EC at 2 gal/A. This injury occurred within one week of application and did not persist.

Summary

Several materials were evaluated for their ability to control Rugel's plantain and Broomsedge. The most active compounds on Rugel's plantain were 74 A 339, Trimec, 3D-weedone, 74 A 325 and 74 A 320. Materials most active on Broomsedge were AMA and AMA + 2,4-D.

Acknowledgements

The author wishes to express his appreciation to the University of Maryland Computer Science Center for computer time made available and to Thomas J. Lavery for technical assistance.

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1. Bandel, V. A., C. K. Stottlemeyer and C. E. Rivard, 1969. Soil Testing Laboratory, Agronomy Mimeo No. 37, University of Maryland, College Park, Maryland 20742.

Table 1. Plant population of Rugels plantain and Broomsedge on May 10, (precount) July 24 and October 4, 1974. Treatments were applied on May 10, 1974.

Treatment	Material Rate	Rugels Plantain			Broomsedge		
		10 May	24 Jul	4 Oct	10 May	24 Jul	4 Oct
		% Cover					
Check	0	22	65	52	22	17	20
74A325 G[a]	100 lb/A	23	8	8	15	25	17
	200 lb/A	21	5	0	18	28	22
74A320 G	71 lb/A	30	15	8	18	27	22
	142 lb/A	17	7	8	15	18	20
Lawnweed Killer G	71 lb/A	13	28	27	13	18	25
	142 lb/A	15	17	27	15	20	22
74A339 EC	1 gal/A	18	2	0	22	35	27
	2 gal/A	23	0	0	18	37	32
3D-Weedone EC	1 gal/A	20	7	5	15	25	19
	2 gal/A	23	0	0	17	32	18
AMA+2,4D EC	8 oz/1000 sq ft	22	15	17	17	13	0
AMA SC	8 oz/1000 sq ft	18	35	60	15	13	3
VEL 4207 EC	1 pt/A	18	40	32	13	17	22
Trimec EC	½ gal/A	30	0	0	23	47	30
Trimec "Home Mix" EC + VEL 4207 EC	½ gal/A + 2 pt/A	17	2	0	15	30	32
		27	17	15	23	27	18
5% Bayes LSD		26	14	14	19	22	20

[a] G=granular formulation, EC=emulsifiable concentrate formulation, SC=soluble concentrate formulation.

Perennial Ryegrass Evaluations

John R. Hall and Andrew J. Powell

Purpose and Objectives

The use of perennial ryegrass (Lolium perenne) for turf is increasing rapidly in Maryland. Many new varieties have become commercially available in recent years and there is an increasing demand for performance information on available varieties.

This study was initiated to evaluate the performance of seven commercially available perennial ryegrass cultivars and a blend of three of these perennial ryegrasses. The objective of the study was 1) to determine which cultivars provided the highest quality turf, and 2) to determine which cultivars provided the greatest density and darkest green color.

Procedures

The perennial ryegrasses were seeded on a Beltsville loam soil at the rate of 5 lb/1000 sq. ft. on October 28, 1970. For the duration of the study soil pH has been maintained between 6.5 and 7.0 and phosphorus and potassium availability has been maintained at medium levels as measured by the University of Maryland Soil Testing procedure (1). The plots were not irrigated once established. The trial area was maintained with 3 lb Nitrogen per 1000 sq. ft. per year applied as 16-8-8. The experimental site was mowed at approximately a $1\frac{1}{2}$" mowing height with both rotary and reel type mowers. Cultivars utilized in the study were all commercially available except for ZW 42.34 and ZW 42.4 which were pasture type perennial ryegrasses of European origin (Table 1). Quality ratings were taken a different number of times each year from April through November. A 1-9 rating system was

utilized where 9 was equal to maximum turfgrass quality, 6 indicated acceptable turfgrass quality and ratings less than 6 indicated unacceptable turfgrass quality. The statistical design was a randomized complete block with 3 replications. Individual plot size was 4' X 6'.

Results

Quality ratings taken in 1974 during the fourth year of development of the perennial ryegrasses indicated that Pennfine and Manhattan provided the highest quality turf over the season (Table 1). Manhattan and Pennfine were superior to Linn, ZW 42.4, Pelo and Norlea in the April rating. There were no significant differences in quality ratings taken in June of 1974 during a relatively dry, hot period. The ryegrasses have not been noted for their ability to provide quality turf through extended periods of low rainfall and high temperatures. By November of 1974 Pennfine had recovered to the point where its quality was significantly better than all other cultivars except Manhattan. For the season, the blend of Pelo - Norlea and Linn achieved higher average quality values than any of the individual components of the blend (Table 1).

1974 Pennfine achieved a seasonal quality rating of 6.0 (Table 2). This was the only time in the four years of testing that any of the cultivars achieved a seasonal average which was indicative of acceptable turfgrass quality. Over the 4 year period of evaluation Manhattan and Pennfine have performed significantly better than the other five cultivars and the blend tested in this trial.

Color ratings taken throughout the duration of this study substantiate that Manhattan, Pennfine and Pelo - Norlea - Lamora blend have provided the darkest green color. Significantly greater density has been achieved over the four years of testing with Manhattan and Pennfine.

Summary

In this study evaluating 7 perennial ryegrass cultivars and a blend of perennial ryegrasses, Manhattan and Pennfine perennial ryegrasses provided significantly better quality and density than the other entries tested. Darkest green color was provided by Manhattan, Pennfine and a blend of Pelo - Norlea - Lemora. The overall turfgrass quality provided by the perennial ryegrasses tested in this trial has been unacceptable. Perennial ryegrasses are generally unable to provide season-long high quality turfgrass surfaces in the College Park area.

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1) Bandel, V. A. and C. E. Rivard. 1975. Soil Testing Methods, University of Maryland Soil Testing Laboratory. 20 pp.

Acknowledgements

The author wishes to express his appreciation for the computer time made available through the facilities of the Computer Science Center of the University of Maryland and to Thomas J. Lavery and Mary A. McLaughlin for their able technical assistance.

Table 1. Quality ratings taken in 1974 on eight cultivars of perennial ryegrass at the Plant Research Farm near Fairland, Maryland.

Cultivar	Quality Rating*			
	April	June	November	Ave.
Linn	4.6 a**	4.6 a	4.6 ab	4.6
Pelo-Norlea-Lamera	5.3 ab	5.3 a	5.3 ab	5.3
Pennfine	6.0 b	5.3 a	6.6 c	6.0
ZW 42.34	5.0 ab	4.6 a	5.0 ab	4.8
ZW 42.4	4.6 a	4.6 a	4.6 ab	4.6
Manhattan	6.0 b	5.3 a	6.0 bc	5.7
Pelo	4.3 a	4.3 a	4.0 a	4.2
Norlea	4.6 a	5.3 a	4.3 a	4.7

* 1-9 Scale is utilized where 1=bare plot 6=acceptable turfgrass quality and 9=maximum turfgrass quality.

** Means followed by the same letter are not significantly different from each other at the 5% level of probability using the new Duncan's Multiple Range test.

Table 2. Average quality ratings taken from 1971 to 1974 on eight cultivars of perennial ryegrass at the Plant Research Farm near Fairland, Maryland.

Cultivar	Quality Rating *				
	1971	1972	1973	1974	Ave.
Linn	4.0	3.0	4.2	4.6	3.9 a **
Pelo-Norlea-Lamera	2.3	3.3	4.5	5.3	3.8 a
Pennfine	5.0	4.6	5.4	6.0	5.2 b
ZW 42.34	3.6	3.4	4.5	4.8	4.1 a
ZW 42.4	3.3	2.6	4.3	4.0	3.6 a
Manhattan	5.3	5.6	5.4	5.7	5.5 b
Pelo	3.3	3.3	4.1	4.2	3.7 a
Norlea	2.6	3.6	4.4	4.7	3.8 a

* 1-9 scale is utilized where 1=bare plot 6=acceptable turfgrass quality and 9=maximum turfgrass quality.

** Means followed by the letter are not significantly different from each other at the 5% level of probability using the New Duncan's Multiple Range test.

Yellow Nutsedge Control in Turf

John R. Hall and J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Yellow nutsedge (Cyperus esculentus L.) is a serious threat to quality turfgrass production in the Mid-Atlantic region. The life cycle of the plant affords only a limited period of time when it can be effectively sprayed with postemergence herbicides. Control of yellow nutsedge with postemergence herbicides frequently necessitates spraying during periods of dry, hot weather and often results in injury to the desirable cool-season turfgrass species. Herbicides currently available have not provided adequate control of this noxious weed. Experimental herbicides have received limited testing for yellow nutsedge control in tall fescue (Festuca arundinacea schreb.)-Kentucky bluegrass (Poa pratensis L.) turf mixtures (3).

The purpose of this study was to compare yellow nutsedge control with bentazon (3-isopropyl-1 H, 2, 1, 3-benzothiadiazone-(4) 3 H-one 2, 2-dioxide), perfluidone (1,1,1-trifluoro-N-(2-methyl-4-(phenylsulfonyl)= phenyl) methanesulfonamide) and 2,4-D ((2,4-dichlorophenoxy) acetic acid) plus DSMA (disodium methanearsonate).

Procedures

The experiment was conducted on a yellow nutsedge infested, disturbed loam soil (41% sand, 40% silt, 19% clay) in Cheverly, Maryland. The sub-surface material was of Christiana origin. The existing turf was a mixture of Kentucky-31 tall fescue and Kentucky bluegrass. Kentucky-31 tall fescue was the dominant species covering approximately 80% of the plot area. Soil pH was 5.7; extractable P_2O_5 135 lb/A, extractable

K_2O 90 lb/A, and organic matter 2.9% (1). All applications were applied in water at the rate of 30 gal/A using CO_2 as the source of pressure in a small plot sprayer delivering the material at 30 psi. The perfluidone and 2,4-D plus DSMA treatments were applied with Ortho X-77 surfactant at the equivalent rate of 4 oz/100 gal water. The experimental design was a randomized complete block with 3 replications and unit plot size of 1.5 by 35 ft.

Treatments (Table 1) were applied on August 23, 1973. On this date the air temperature was 75 F and the soil temperature at the 0-6 inch range was 76 F. The turf was maintained at a 2.5 inch mowing height and was fertilized in September and October 1973 and in March of 1974 with a total of 18 lb of 16-8-8 per 1000 sq. ft. applied in three 6 lb applications. The plot area was overseeded to Kentucky-31 tall fescue at the rate of 2 lb/1000 sq. ft. in late October 1973 and 50 lb/1000 sq. ft. of agricultural limestone was applied in March of 1974. To avoid seed dispersal, the clippings were collected on the plot during the period when yellow nutsedge was actively forming inflorescences. Data were taken on September 25 and November 30, 1973 and on September 10, 1974 (33, 99 and 382 days after treatment, respectively). Percent plot area estimations were recorded as the average of two individual's ratings. Yellow nutsedge populations were determined by counting all plants in the 52.5 sq. ft. plot.

Results

Temperatures during the period from August 27 to September 2, 1973 averaged 85 F and were 11 F above normal and precipitation during this same period was 1 inch below normal (2). This hot, dry weather did have varying effects upon the performance of the materials tested. Visual observation indicated a good kill of yellow nutsedge seven days after application of bentazon at both rates. The crown tissue exhibited severe

necrosis and the plants were easily pulled from the soil. At that time, no effect on tall fescue was observed. Yellow nutsedge plants in the perfluidone plots appeared similar to the plants in the check plots after 7 days. The plants in the 2,4-D plus DSMA plots were necrotic and the crown tissue was brown 7 days after treatment application. The 2,4-D plus DSMA treatment did provide control of smooth crabgrass (Digitaria ischaemum (Schreb.) Muhl.). Eleven days after application it was observed that the yellow nutsedge in the perfluidone plots had stopped initiating new roots and the existing roots did not appear as healthy as those in the check plots. Shoot growth in these plots appeared stunted at this time. In the 2,4-D plus DSMA plots, the older leaves of the yellow nutsedge were still green eleven days after application but the young leaves near the crown tissue were brown. The 2,4-D plus DSMA treatment did injure the turf by burning the foliage in one replication, but this injury was temporary.

Bentazone and 2,4-D plus DSMA provided quick kill of the above-ground yellow nutsedge plant parts (Table 1). Perfluidone was slower acting and by September 25, 1973 many plants still appeared to be living as confirmed by plant counts and visual estimates of the plot area covered with yellow nutsedge. The correlation between plant count and visual estimate of plot area covered with yellow nutsedge was highly significant ($r = .979$) indicating the reliability of visual estimates to reflect plant count in this instance.

By September 25, 1973 a reduction in the stand of tall fescue in certain plots was evident (Table 1). Perfluidone and bentazon treatments appeared to significantly reduce the percent of the plot area in tall fescue. This observation could have been influenced by the extremes of weather discussed above. Because of the late October overseeding of the plot area with tall fescue, the permanency of tall fescue injury

could not be determined.

The bentazon and perfluidone treatments did negatively influence the quality of the predominantly tall fescue turf for at least 99 days (Table 2). These quality differences were primarily the result of thinning of the tall fescue stand in the tall fescue-Kentucky bluegrass mixture (Table 1).

On September 10, 1974, approximately 13½ months after the initial application, yellow nutsedge plant counts indicated that the best control of yellow nutsedge with a single application was achieved with bentazon at the .75 lb ai/A rate (Table 2). This degree of control was not significantly different at the 5% level from that achieved with bentazon at 1.5 lb ai/A, perfluidone at 4.0 lb ai/A, or 2,4-D plus DSMA at 1.0 + 5.0 lb ai/A. The only treatments providing control of yellow nutsedge that were significantly better than the check 382 days after application were bentazon at .75 lb ai/A and perfluidone at 4.0 lb ai/A.

It appears that multiple applications of these materials are necessary for acceptable control of yellow nutsedge.

Summary

Bentazon, perfluidone and 2,4-D plus DSMA were tested for their ability to control yellow nutsedge in a turfgrass mixture of tall fescue and Kentucky bluegrass. Bentazon and 2,4-D plus DSMA affected good initial kill of existing yellow nutsedge. Bentazon and perfluidone injured the tall fescue under the dry, hot post-spray conditions of this experiment. Approximately 13½ months after the initial application, bentazon at 0.75 lb ai/A and perfluidone at 4.0 lb ai/A provided yellow nutsedge control of 79% and 61%, respectively. Bentazon at 1.5 lb ai/A, perfluidone at 3.0 lb ai/A and 2,4-D plus DSMA at 1.0 + 5.0 lb ai/A provided 40%, 16% and 30% control, respectively.

Acknowledgements

The authors wish to express their appreciation for the computer time made available through the Computer Science Center of the University of Maryland and to Thomas J. Lavery and Mary A. McLaughlin for their able technical assistance.

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3. Jagschitz, John A., 1973. Evaluation of herbicides for nutsedge control in turfgrass, Proc. Northeast. Weed Sci. Soc. 27:311-333.

Table 1. Effect of bentazon, perfluidone and 2,4-D plus disodium methanearsonate upon percent of plot area in nutsedge, number of nutsedge plants per plot and percent of plot area in tall fescue on September 25, 1973, 33 days after treatment.

Treatment		Area of Plot in living yellow nutsedge[x]	Yellow Nutsedge plants per 52.5 sq. ft.	Area of Plot in tall fescue[x]
Chemical	Rate (lb ai/A)	(%)	(number)	(%)
Bentazon	.75	0 a[y]	0 a	17 a
	1.5	0 a	0 a	5 a
Perfluidone	3.0	12 b	60 b	20 a
	4.0	12 b	64 b	15 a
2,4-D plus	1.0			
Disodium	+	0 a	0 a	38 b
methanearsonate	5.0			
Check	0	32 c	187 c	58 c

[x]Visual estimates recorded as average of two individual's ratings made in 5% increments.

[y]Columnar means with the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range Test.

Table 2. Effect of bentazon, perfluidone and 2,4-D plus disodium methanearsonate upon quality of the turfgrass on November 30, 1973 (99 days after treatment) and percent control of yellow nutsedge on September 10, 1974 (382 days after treatment).

Treatment		Turfgrass Quality Rating 11/30/73	Yellow Nutsedge Control 10/10/74[z]
Chemical	Rate (lb ai/A)	(rating)[x]	(%)
Bentazon	.75	4.6 a[y]	79 c
	1.5	4.3 a	40 abc
Perfluidone	3.0	4.0 a	16 ab
	4.0	4.6 a	61 bc
2,4-D plus	1.0		
Disodium	+	6.3 a	30 abc
methanearsonate	5.0		
Check	0	6.6 a	0 a

[x]Turfgrass quality rating made on a 0-9 scale with 9=maximum turfgrass quality and 0=bare plot. A rating of 6 or greater is considered acceptable.

[y]Columnar means with the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range test.

[z]Total number of yellow nutsedge plants in each plot was determined and percent control achieved was calculated by comparison with the check plot in each replicate.

Breeding and Evaluation of Kentucky Bluegrass for Turf

J. R. Hall
Department of Agronomy

Purpose and Objectives

Continuous evaluation of promising selections of Kentucky bluegrass (*Poa pratensis* L.) is essential in order to determine which cultivars are capable of providing quality turf in Maryland. There are currently more than 50 cultivars available to amateur and professional turfgrass managers. Some commercially available varieties selected from cool, moist climates have little potential for surviving the hot, humid Maryland summers. It was the purpose of this test to evaluate new experimental and commercial cultivars to determine which were most likely to provide quality turf in Maryland.

The objectives of this study were:

1) To compare the first and second year performance of seventy cultivars alone and in combination.
2) To determine color, density and quality differences between the cultivars.

Procedure

Fifty-one individual cultivars and nineteen combinations of cultivars were seeded in the spring of 1972 in a randomized complete block experimental design with three replications and individual plot size of 4' X 6'. The experiment is located at the Plant Research Farm near Fairland, Maryland on a Chillum silt loam (45% sand, 36% silt and 19% clay). The plots were maintained at a 1" mowing height and were not irrigated unless drought threatened survival. Maintenance

fertilization was applied as readily available nitrogen (16-8-8) at 3 lb N/1000 sq. ft./year in split applications. Applications were made in 1 lb N/1000 sq. ft. increments in September, October and February of each 12 month period.

From April 1973 to November 1973 monthly color, density and quality ratings were taken. Disease damage was recorded as it occurred. All ratings were made on a 1-9 scale with 9 equal to a maximum value. A rating of 6 or greater was considered to be acceptable. Quality ratings reflect the ability of each cultivar or blend of cultivars to maintain a dense, firm, smooth, pest-free turfgrass surface. The six basic components of turfgrass quality: Uniformity, density, texture, growth habit, smoothness and color are considered in making the quality ratings. The relative importance of these components varies with the purpose for which the turf is to be utilized. In this instance where the cultivars are being evaluated at a 1" mowing height for possible use on golf course fairways, smoothness and density are of utmost importance.

Results

In 1973 only 19 of the 70 entries were capable of providing a seasonal turf quality which was acceptable over the entire season. (Quality rating greater than 6.0) In 1974 as the turfgrasses began to mature, thirty five of the 70 entries provided an average quality rating greater than 6.0 for the season (Table 1). However, in 1974 only 14 of the 70 entries were capable of providing acceptable quality turf in every month of evaluation. These exceptional varieties were Fylking, Victa, Vantage, Windsor, NJE P-57, KI-155, KI-157, NJE P-59, Parade, EVB 282, Pennstar, a blend of Vantage + Victa, NJE P-141, and NJE P-151. Seasonal averages can be misleading as some varieties perform well for 6 of the 8 months of testing but have a

couple of months where they fail to provide adequate turfgrass quality.

Nuggett, Campina, Kenblue, Park and Delft continue to show unacceptable susceptibility to Helminthosporium spp. causing leaf spot. These common Kentucky bluegrasses can only serve to provide persistence to a blend. The performance of Merion was less than acceptable from June through early September. Glade, which is tauted for its shade tolerance, appears to function quite well in full sun. Windsor, Vantage and Victa all performed very well with none of the three ever receiving a less than acceptable rating in 1974. Sydsport's previously reported dollar spot susceptibility did not develop in 1974. Parade, Monopoly and Bonnieblue bear watching as they are commercially available and are showing promise in Maryland. Combinations of Fylking + C-26 performed better than combinations of Fylking + Jamestown seven of the eight months quality ratings were taken. Fylking + Pennlawn was better than Fylking + Jamestown in all eight months of rating. Combinations of Nuggett + other Kentucky bluegrasses tended to lower the quality rating below the level achieved by the other Kentucky bluegrass alone except in the case of Nuggett + Park where the combination was better than either cultivar alone. Nuggett has been generally unsuited for Maryland.

The standard Maryland seed mixtures of 40-40-20 (40% Merion Kentucky bluegrass + 40% South Dakota Certified Kentucky bluegrass (SDC) + Pennlawn creeping red fescue) and 30-30-30-10 (30% Merion + 30% SDC + 30% Fylking) were especially disappointing with seasonal quality ratings of 5.50 and 5.54, respectively. Blends in the state of 30-30-30-10 with Adelphi replacing Fylking have performed exceptionally well.

NK-200 perennial ryegrass provided a totally unsuitable turf and during the periods of July, August and September was exceptionally poor.

The mixtures of Kentucky bluegrass and Perennial ryegrass did not perform well. The perennial ryegrass is tending to clump even when combined with Kentucky bluegrass at as low as 5, 10 and 15% of the mixture by weight. During the periods of June, July and August the ryegrass tends to fray even when mowed with recently sharpened mowers.

Exceptionally dark green color has been noted in several of the varieties being tested, of exceptional note are Glade, Fylking, Baron, Ba 61-91, Windsor, Sydsport, Majestic, Kl-155, MLM 1800, Adelphi, EVB 282, and EVB 391.

In May of 1974 exceptional resistance to Helminthosporium leaf spot (Helminthosporium vagans was isolated from the area) was noted on NJE P-142, Victa, Windsor, Sydsport, Majestic, Galaxy, NJE P-57, Kl-155, NJE P-59, MLM 18001, EVB 307, EVB 309, Merion + Pennstar, Vantage + Victa, PSU 190, PSU 197, and Warrens A-34.

The data indicate that in 1973 and 1974 thirteen and twenty seven percent, respectively, of the entries tested were capable of providing acceptable turfgrass quality from April through November under environmental and edaphic conditions existing in Maryland. This information is vital in establishing turfgrass recommendations for the State of Maryland. Varieties are evaluated for a minimum of 3 years before they are recommended by the University of Maryland. Certified seed of the cultuvars must be available before recommendation will be considered. Final recommendations are made based upon experimental and field performance of the varieties.

Summary

The author wishes to express his appreciation for the computer time made available through the facilities of the Computer Science Center of the University of Maryland and to Thomas J. Lavery and Mary A. McLaughlin for their able technical assistance.

Table 1. 1974 Quality ratings for fifty-one single cultivars and nineteen combinations of cultivars tested at the Plant Research Farm near Fairland, Maryland.

Cultivar	Quality Rating[a]								Average Quality Rating
	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	
Nuggett	3.00	3.00	4.33	4.00	4.33	4.33	5.33	5.33	4.21
Merion	6.67	6.67	5.67	5.67	5.33	5.00	6.67	7.00	6.09
Fylking	6.67	7.00	7.00	6.67	6.67	6.33	7.00	7.67	6.88
Glade	6.00	6.00	6.67	6.00	5.67	6.00	6.67	6.67	6.21
P-142	5.33	5.67	6.00	5.33	5.00	5.00	6.67	6.67	5.71
Kenblue	7.00	5.33	4.67	5.00	5.00	4.67	6.00	6.00	5.46
Baron	7.00	6.67	6.67	6.00	5.67	5.33	6.67	6.67	6.34
Victa	6.33	6.33	6.67	6.00	6.33	6.00	7.33	6.67	6.46
BA 61-91	6.00	6.00	7.33	6.33	6.33	5.33	7.33	7.00	6.46
BA 62-55	5.67	5.67	6.00	5.33	5.67	5.33	6.33	6.33	5.79
Vantage	7.00	6.67	6.33	6.67	6.67	6.00	7.00	7.33	6.71
Park	7.00	5.67	5.00	4.67	4.67	4.67	6.00	6.33	5.50
Windsor	7.67	7.33	7.00	7.00	7.33	6.67	8.00	7.67	7.33
Sydsport	5.67	5.67	6.67	6.33	6.00	6.00	6.67	7.33	6.29
Bonnieblue	5.67	6.00	7.33	7.00	7.00	5.67	6.67	7.00	6.54
Majestic	6.33	6.00	6.67	6.00	5.67	5.67	6.67	7.33	6.29
Campina	4.67	4.33	4.67	4.67	4.33	4.00	5.33	5.33	4.67
Monopoly	8.00	7.67	7.00	5.67	5.67	5.67	6.33	7.00	6.63
Galaxy	6.00	5.67	6.67	6.33	5.67	4.67	5.67	5.00	5.71
Geronimo	6.33	6.33	6.33	5.33	5.67	5.33	5.67	6.00	5.87
P-57	7.33	7.33	7.67	7.00	6.33	6.33	7.33	7.33	7.08
K1-131	6.67	6.33	7.00	6.00	4.67	4.67	5.33	6.00	5.83
K1-132	7.00	6.33	7.33	5.33	4.67	3.67	4.33	5.33	5.50
K1-133	6.67	6.33	6.67	5.33	4.00	3.33	4.00	4.33	5.08
K1-138	5.33	5.00	5.67	5.67	4.67	4.33	6.33	6.00	5.38
K1-143	6.00	6.00	7.33	5.33	4.33	4.33	5.67	5.33	5.54
K1-155	7.00	7.33	7.00	6.67	6.67	6.33	8.00	8.00	7.13
K1-157	7.00	6.67	7.33	6.67	6.67	7.00	7.67	7.33	7.04
K1-158	7.00	5.33	5.67	5.00	5.67	5.67	7.67	7.33	6.17
K1-187	7.00	6.67	7.33	6.00	5.00	5.33	5.33	6.00	6.08
P-59	7.00	7.67	7.00	7.00	7.00	6.00	7.67	7.00	7.04
Sodco	6.33	6.00	6.33	5.67	5.67	5.33	7.00	7.00	6.17
MLM 18001	5.67	5.33	6.33	6.00	6.00	5.33	6.67	7.00	6.04
Adelphi	6.67	6.33	6.67	6.00	5.67	5.67	7.33	7.33	6.46
Parade	7.67	7.33	6.67	6.00	6.33	6.33	8.00	7.33	6.86
EVB 282	7.67	6.67	7.33	6.67	6.33	6.00	7.33	8.00	7.00
EVB 305	5.00	4.67	5.33	5.00	5.67	5.00	5.00	6.00	5.21
EVB 307	5.00	4.33	5.67	4.67	5.67	4.67	5.00	5.33	5.04
EVB 391	6.67	7.33	7.00	5.67	5.33	5.33	6.00	7.33	6.96
Pennstar	6.00	6.33	6.67	6.00	6.00	6.00	6.33	7.33	6.33
Mer + Kenblue	6.00	5.00	5.67	5.00	5.33	5.67	6.00	6.33	5.63
Mer + Pennstar	6.00	6.33	6.00	5.67	6.00	6.00	6.67	6.67	6.17
Mer + Baron	6.00	5.67	6.33	6.00	5.67	6.00	6.33	7.00	6.13
Nuggett + Pennstar	4.33	4.00	5.67	5.00	5.00	5.00	5.33	5.67	5.00
Nuggett + P-29	5.33	5.67	6.67	6.00	5.67	5.33	6.33	6.67	5.96
Nuggett + Park	6.33	5.67	5.67	5.33	5.33	5.33	6.33	6.33	5.79

Table 1 (con't)

Cultivar	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Ave.
BA 61-24+BA 62-54	7.33	7.00	6.67	7.00	7.00	7.00	7.00	7.33	7.04
P-57 + P-59	7.33	7.00	7.00	6.33	6.00	5.33	7.33	7.00	6.67
Fylking+Jamestown[b]	5.33	5.67	6.00	5.00	5.00	5.00	5.00	6.00	5.38
Fylking+C-26[b]	5.67	6.00	7.00	6.00	5.67	5.67	6.33	6.33	6.08
Fylking+Pennlawn[b]	6.00	6.00	6.33	5.67	5.33	5.33	5.67	6.33	5.83
Fylking+Pennfine[c]	6.33	5.33	5.33	5.00	4.67	4.33	5.33	6.00	5.29
Delft	5.33	5.33	5.33	5.33	4.67	4.67	4.67	4.67	5.00
PSU-190	7.33	6.67	7.00	6.67	5.67	5.33	6.33	7.00	6.50
PSU-150	6.00	5.33	6.00	5.00	5.67	5.33	6.67	6.33	5.79
RAM #2	6.33	6.33	7.00	5.33	5.00	4.67	5.33	5.67	5.71
P-133	6.67	6.67	7.00	6.00	5.67	5.67	7.67	7.00	6.54
PSU-197	5.67	5.67	6.33	6.67	6.33	6.00	6.67	7.00	6.29
P-141	7.00	6.33	7.00	6.33	7.00	6.33	7.67	7.33	6.87
P-151	6.00	6.00	6.67	6.33	6.33	6.00	6.67	6.67	6.33
PSU-169	5.00	5.67	6.00	5.00	5.00	5.33	6.33	6.00	5.54
Adelphi+Nuggett	6.00	6.00	6.33	6.67	5.33	5.33	6.00	6.67	6.04
Blend 38[d]	6.33	6.33	7.00	6.00	6.67	5.67	7.33	7.33	6.58
40-40-20[d]	6.00	5.67	5.67	5.33	5.00	5.00	5.67	5.67	5.50
30-30-30-10[d]	6.33	6.00	6.00	5.00	5.00	4.67	6.00	5.33	5.54
NK-200[c]	5.00	5.00	4.67	3.67	3.33	2.00	3.33	3.67	3.83
95%Mer+5%NK-200[c]	5.67	5.67	6.00	5.00	4.67	4.33	5.67	6.33	5.42
90%Mer+10%NK-200[c]	5.67	6.00	5.00	4.67	4.67	3.67	4.67	5.33	4.96
80%Mer+20%NK-200[c]	5.00	5.00	5.00	5.00	4.33	3.67	4.67	5.00	4.71
A-34	7.67	7.33	7.67	6.33	6.00	5.67	7.33	6.67	6.83
5% Bayes LSD	1.32	1.10	1.09	1.19	1.76	1.45	1.49	1.25	----

[a]Quality rating system is 1-9 with 1=almost bare plot, 6=acceptable turfgrass quality and 9=flawless turfgrass quality.

[b]Jamestown, C-26 and Pennlawn are red fescue cultivars.

[c]Pennfine and NK-200 are perennial ryegrass cultivars.

[d]40-40-20 is 40% Merion Kentucky bluegrass, 40% South Dakota Certified Kentucky bluegrass and 20% Pennlawn creeping red fescue.

30-30-30-10 is 30% Merion, 30% South Dakota Certified Kentucky bluegrass, 30% Fylking Kentucky bluegrass and 10% Pennlawn Creeping red fescue.

Tee Turf Research

D. T. Hawes
Department of Agronomy

Purpose and Objectives

This experiment was designed to determine if increased traffic resistance can be obtained by a combination of management techniques and mixtures of traffic resistant grasses. More traffic resistant turf will benefit golf courses, athletic fields, tennis courts and schools.

The objectives were: (1) to evaluate the traffic bearing potential of zoysiagrass, bermudagrass, bluegrass and bentgrass alone and in two-way combinations and (2) to determine management factors that provide the greatest healing potential, quality and traffic resistance.

Procedures

In the early summer of 1973, stolons of 'Meyer' and 'Midwest' Zoysia and 'Tufcote' and 'Tifgreen' bermudagrass were planted at a rate of 4 bushels per 1,000 sq. ft. The plot design was a split-split plot with four replications. Individual plot size was 5' by 5'. Plots were located on a Beltsville silt loam at the Hopkins Plant Research Farm.

In September, 1973, the four warm season varieties were overseeded to a blend of five Kentucky bluegrass varieties and to 'Penncross' creeping bentgrass. Thus warm season and bluegrass combinations will be evaluated and compared to warm season and bentgrass combinations as well as pure stands of each species. All plots received 10 lbs. N/1000 sq. ft. as NH_4NO_3 during the first year establishment phase.

In May of 1974, 1/8 inch of topdressing was applied over one-half of each replication. This will be repeated three times each year. Also on this date, a warm and a cool season nitrogen fertilizer program was initiated on the above treatments. Plots were mowed at 3/4 inches in the summer and 1 inch in the winter season.

Results

The results reported here are of the first summer's growth. Thus the trends reported here reflect growth under conditions which favored the warm season species, zoysia and bermuda.

Both visual estimates of percent composition and dry weight verdure samples taken in May, 1974 indicate that zoysia was reduced by competition from a bentgrass overseeding. By September, 1974, the percentage of zoysia in bentgrass was significantly less than that in the bluegrass plots or the pure zoysia (Figure 1.). There was no measurable influence in the amount of zoysia from the two fertilizer programs.

Bermudagrass did not show any significant reduction by bentgrass competition, although there was a season long trend for there to be a lower percentage of bermuda when grown in competition with bentgrass as compared to bluegrass (Figure 2.). Bermudagrass dominated over both cool season grass under both fertilizer programs. There was a strong trend for less domination of bentgrass by 'Tifgreen' than by 'Tufcote'.

Visual estimates in September of the percentage 'Tifgreen' were significantly less for the 'Tifgreen'-'Penncross' plots under the cool season fertilizing program than under the warm season program. The amount of 'Tifgreen' in combination plots with 'Penncross' was also significantly less than the amount of 'Tufcote' found in 'Tufcote'-'Penncross' plots.

The percentage of bentgrass when grown in combination with zoysia always remained greater than when grown in combination with bermuda (Figure 3.). In July and September both verdure samples and visual estimates showed the percentage of bentgrass in zoysia plots to be significantly higher than that in bermuda plots.

The percentage of bluegrass decreased irregardless of treatment from July to September (Figure 4.). There was a significantly higher percentage

of bluegrass in zoysia than in bermuda combinations by September. The percentage of bluegrass appeared to be greater under the cool season fertilizer treatment when grown pure or with zoysia. Fertilizer treatments did not affect the percentage of bluegrass when it was grown in combination with bermuda.

Summary

The first summer's data show only slight increase in zoysia with an adverse effect of bentgrass on zoysia growth. Bermudagrasses showed large increases in % cover during the summer resulting in an almost complete dominance over bluegrass. Bentgrass was better able to compete with the 'Tifgreen' bermuda than with 'Tufcote' and competed better with both bermudas than bluegrass did.

Percentage composition shown by combining visual estimates and dry weight verdure samples in 1974.
Values are averages over two fertility treatments and two topdressing treatments.

Figure 1. PERCENTAGE OF PLOT IN ZOYSIA

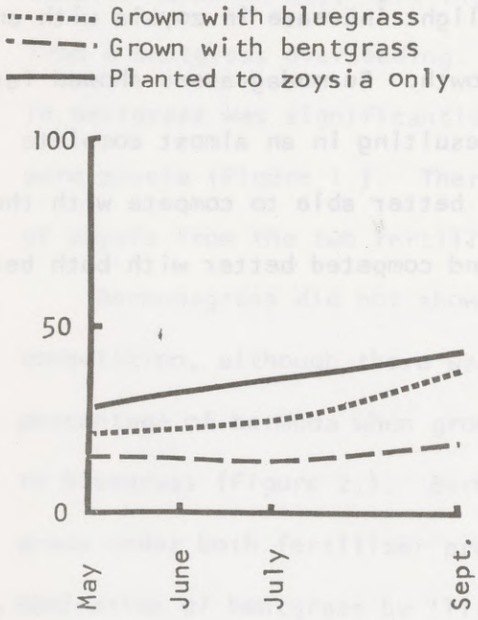
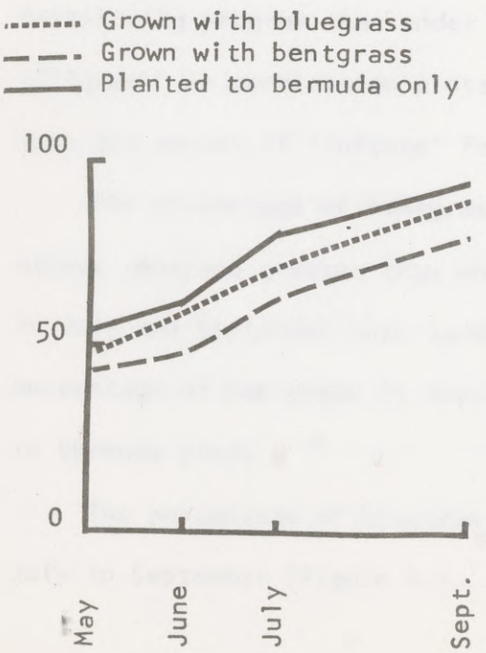


Figure 2. PERCENTAGE OF PLOT IN BERMUDA



Percentage composition shown by combining visual estimates and dry weight verdure samples in 1974.
Values are averages over two fertility treatments and two topdressing treatments.

Figure 3. PERCENTAGE OF PLOT IN BENTGRASS

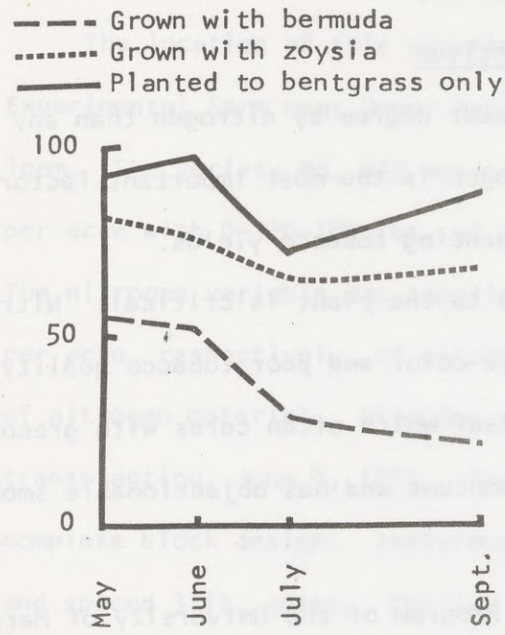
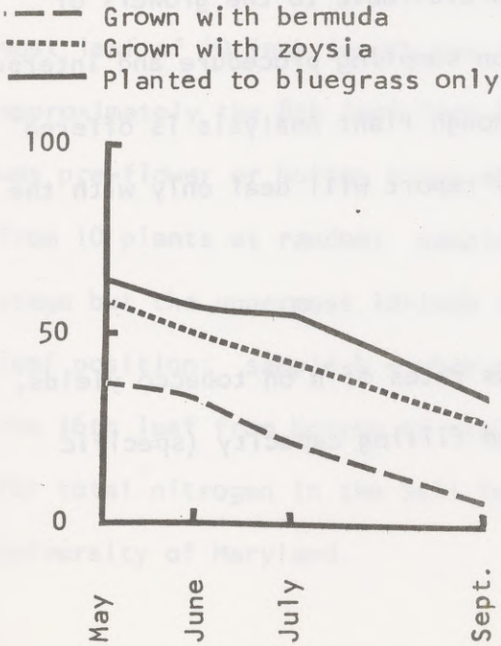


Figure 4. PERCENTAGE OF PLOT IN BLUEGRASS



Effect of Nitrogen on Tobacco Performance and Correlations of Total Nitrogen Analysis With Tobacco Yields

J. H. Hoyert and V. A. Bandel
Department of Agronomy

Purpose and Objectives

Plant growth is influenced to a greater degree by nitrogen than any other fertilizer material. In fact nitrogen is the most important factor under control of the average grower influencing tobacco yields.

The correct availability of nitrogen to the plant is critical. Nitrogen deficiency results in low yields, pale-color and poor tobacco quality. Too much nitrogen gives a slow maturing leaf which often cures with greenish colors, is high in alkaloid and protein content and has objectionable smoking taste.

The Soil Testing and Plant Analysis Program of the University of Maryland offers growers an opportunity to have a plant analysis made of his crop and this is a potential means of checking the nitrogen status of tobacco during growth. Although plant analysis is available to the growers of Southern Maryland, information is needed on sampling procedure and interpretation of the laboratory results. Even though Plant Analysis is offered for most plant nutrients, this preliminary report will deal only with the critical N content of tobacco leaves.

The objectives of this work were:

1. To determine the effect of various rates of N on tobacco yields, price per cwt., value per acre and filling capacity (specific volume).

2. To investigate variation of total N with leaf position and stage of plant growth at time of sampling.
3. To study the correlations of yield per acre at the different N levels with total N content of the various leaf samples.

Procedure

The location of this experiment was the University of Maryland Tobacco Experimental Farm near Upper Marlboro. The soil was a Monmouth fine sandy loam. The variety Md. 609 was transplanted at a population of 6223 plants per acre with 0-120-180 lbs. of tobacco fertilizer broadcast per acre. The nitrogen variable was supplied at rates of 0, 30, 60, 120 and 240 lbs. per acre, respectively, of nitrogen with ammonium nitrate used as the source of nitrogen material. Nitrogen was applied by sidedressing on the day of transplanting, June 8, 1973. Four replicates were used in a randomized complete block design. Individual plots contained 4 rows of 37 ft. long and spaced 3 ft. apart. The two middle rows were harvested from each plot on August 13, 1973.

Leaf samples were taken for total nitrogen analysis as follows: sample 1 — when plant was at the knee-high stage of growth and the uppermost leaf of 10 inch length was taken from 10 plants at random. This was approximately the 8th leaf from bottom of stalk.; sample 2 — when plant was pre-flower or button stage and 3rd leaf from bottom of stalk was taken from 10 plants at random; sample 3 — when plant was at same pre-flower stage but the uppermost 10-inch leaf was taken which was approximately 13th leaf position; sample 4 — when plant was completely cured and approximately the 16th leaf from bottom of stalk was taken. These samples were analyzed for total nitrogen in the Soil Testing and Plant Analysis Laboratory of the University of Maryland.

Cured leaf data was recorded for yield and value per acre, and price per cwt. Filling capacity, an index of the number of cigarettes a given weight of tobacco will fill was determined by the standard method. Correlation coefficients were calculated between acre yields and the various determinations of total leaf N.

Results

Table 1 presents the results of tobacco performance and the plant analysis for total nitrogen taken at different growth stages and various leaf positions.

Yield per acre increased with high significance for each addition of N. The yield was almost doubled by applying 240 lbs. of N per acre when compared to the 0 rate used as a control treatment. There was no significant difference in the price per cwt. However a trend of increased price appeared through the 60 lbs. N rate and then the price decreased at the 120 lb. rate and was the lowest of all treatments at the 240 lb. rate of N. Value per acre was largely controlled by the yield with a consistent increase with each added increment of nitrogen. The trend for volume weight was down with increased N although this decrease was not significant.

The leaf analysis for total N indicated higher correlations between yields and total N for leaves not fully matured. When the plant was knee-high the 8th leaf position gave a correlation coefficient of +.82 and at the pre-flower stage the 13th leaf position resulted in +.90 correlation coefficient. The cured 16th leaf taken from the cured plant gave a correlation coefficient of +.84. These three samples were of leaves in a relatively immature stage of growth. A correlation coefficient of +.70 resulted when matured leaves were sampled at the 3rd leaf from the bottom of the stalk taken at the pre-flower stage of growth.

Summary

Preliminary results were obtained upon the effect of nitrogen applications on tobacco performance and correlations were determined for total leaf nitrogen with tobacco yields. Nitrogen rates included 0, 30, 60, 120 and 240 lbs. per acre of actual nitrogen. Total nitrogen in the leaf samples was determined to investigate its variation with leaf position and stage of plant growth. Tobacco yield per acre increased with each increment of nitrogen. Acre yield was almost doubled by applying 240 lbs. of N per acre when compared to the 0 rate used as a control treatment. Value per acre showed a consistent increase with each added increment of nitrogen. Results of the 1973 tests indicated a higher correlation between yield and total leaf nitrogen for the less mature leaf positions.

Table 1. Effect of fertilizer N on tobacco performance and total N content of certain selected leaves. 1973.

Nitrogen Treatment lbs/A	Yield lbs/A	Price/Cwt.	Acre Value $/A	Volume Wt. cc/gm.	Total N Knee-High 8th leaf %	Total N Pre-Flower 3rd leaf %	Total N Pre-Flower 13th leaf %	Total N Cured 16th leaf %
0	1182	81.64	965	5.13	4.05	1.58	3.68	2.50
30	1529	81.93	1252	4.78	4.50	1.78	4.43	3.00
60	1745	83.33	1450	4.95	4.88	1.95	4.85	3.20
120	1974	81.39	1605	4.23	5.18	1.98	5.05	3.65
240	2239	80.09	1794	3.75	5.30	2.33	5.75	5.33
L.S.D. (.05)	152	N.S.	124	N.S.	0.56	N.S.	0.54	0.80
(.01)	213	N.S.	177	N.S.	0.78	N.S.	0.76	1.13
					+0.82 *	+0.70 *	+0.90 *	+0.84 *
C.V.	5.7%	1.6%	5.8%	15.5%	7.6%	18.4%	7.4%	15.0%

* Correlation coefficient between yields and total N for selected leaves.

Regional Tests With Tobacco Sucker Control Agents on Maryland Tobacco

J. H. Hoyert and G. L. Steffens
Department of Agronomy and
Plant Physiology Institute, U.S.D.A.

Purpose and Objectives

Plant growth regulators have been used to inhibit the growth of tobacco suckers in all types of tobacco. However, some undesirable effects on the chemical and physical properties of the tobacco and possibly the health of consumers have been suggested. Consequently, studies have been going on for some time on a regional basis to find other chemicals and methods of sucker control which would be more suitable. (This approach has been through the Regional Tobacco Growth Regulator Committee which involves 10 states, U.S.D.A., EPA, many chemical companies, most of the domestic tobacco companies and one foreign tobacco company. This regional research was instigated by the U. S. House of Representatives).

Maryland is a participant in this regional research and the report herein will deal with 1974 results in Maryland to determine the effectiveness of several sucker control agents on tobacco yield, price, acre values and sucker control.

Procedure

The experiment was conducted on a Monmouth fine sandy loam at the Tobacco Experimental Farm. Md. 10 variety was transplanted on June 10 with 75-120-180 lbs. of fertilizer broadcast per acre. Topping was completed on August 8 when 70% of the plants showed at least some open flowers. Suckers were removed after 14 days, counted and weighed. The control treat-

ment which was not suckered served as a basis for calculating the percent sucker control. Treatments studied were: topped unsuckered control, maleic hydrazide (Uniroyal), Off-Shoot-T (Procter and Gamble), TD6825 and TD6826 (Armak), P293 (Uniroyal) and Balan (Lilly). Sucker control treatments were applied immediately after topping on August 8, 1974.

Results

Higher cured leaf yields and acre dollar values were obtained from tobacco treated with all of the sucker control agents as compared to values from the untreated control as shown in Table 1. Yield increases ranged from 207 lbs. per acre for TD6826 to 529 lbs. per acre for Balan. There were corresponding increases in acre values of $198 per acre from TD6826 to $494 per acre from the Balan treatment. There were no important differences in the price per hundredweight between any of the treatments. Control of suckers was better for all suckering agents when compared to the untreated check. Percent control by suckering agents ranged from 37 to 98 percent with Balan, P293 and maleic hydrazide giving 98, 96 and 88 percent control of suckers, respectively. There were no leaf injury symptoms observed for any of the treatments in 1974. Phytotoxic effects frequently occur with the use of some suckering agents.

Summary

Regional sucker control tests were conducted on Maryland tobacco to determine the effectiveness of various suckering agents on degree of sucker control. yield, price and acre values of tobacco. All of the suckering materials gave better results than the untreated control. Maleic hydrazide, P293 and Balan gave superior control compared to Off-Shoot-T, TD6825 or TD6826. Significantly higher yields and acre values resulted from all chemicals tested when compared to the untreated check. There were no important differences in price per hundredweight for tobacco from any of the treatments including the control treatment.

Table 1. The effects of Sucker Control Treatments on Sucker Growth, Cured Leaf Yield and Price — Maryland Tobacco Advanced Regional Tests. 1974.

Treatment	Sucker Growth				Cured Leaf		
	Sucker Control [1] %	Weight /Plant gms	Weight /Sucker gms	Suckers /Plant No.	Yield /Acre Lbs	Price $/Cwt	Acre Value $/A
Control	0	193	22	8.6	1434	88.41	1268
Maleic Hydrazide	88	24	6	4.3	1699	89.89	1528
Off-Shoot-T	69	55	7	7.3	1776	90.17	1603
TD6825	61	69	8	8.2	1702	90.06	1533
TD6826	37	102	9	11.5	1641	89.26	1466
P293	96	9	10	1.8	1664	89.31	1490
Balan	98	2	11	0.1	1963	89.76	1762

[1] % by which treatment reduced sucker green weight compared to check.

Effect of Sucker Control Agents, Method of Application and Time of Harvest on Maryland Tobacco

J. H. Hoyert
Department of Agronomy

Purpose and Objectives

Maryland growers have converted to the use of sucker control chemicals in the past few years. There are practical problems in the application of suckering agents brought on by the reliance of many large growers on custom operators. It is necessary for the custom operator to treat the grower's total tobacco acreage in one visit as it would be too costly to make repeat visits to the farm. It is often impossible for the grower to top his entire crop before the applicator visits because of labor restrictions. Thus there are practical advantages for custom operators to apply sucker control agents to untopped tobacco.

Another problem resulting from decreased labor availability is that tobacco is now harvested over longer periods of time after topping which could have a significant effect on quality and yield. Maryland leaf is noted for its thin body and high filling power — quality characteristics that must be preserved.

Systemic sucker control agents are most popular in Maryland but contact type chemicals have some place on small crop acreages. Combinations of systemic and contact sucker control agents have proven profitable in the flue-cured area and should be investigated under Maryland conditions which are considerably different than flue-cured.

Consequently this study was initiated to compare sucker control agents and different methods of application. The objectives were:

1. To compare chemical suckering agents and various methods of application of these suckering agents and their effect on sucker control, yield, price and acre values of Maryland tobacco.
2. To determine the effect of time between treatment and harvest for various sucker control methods on yield, price and acre values and sucker control.

Procedures

This experiment was located on a Monmouth fine sandy loam at the Tobacco Experimental Farm. Md. 10 variety was transplanted at a population of 6,223 plants per acre with 70-120-180 lbs. of fertilizer broadcast per acre. Four replicates were used in a split plot design with the time of harvest as whole plots and sucker control methods as the sub plots.

Transplanting was carried out on June 6, 1974 and topping was completed August 12, 1974 when approximately 70% of the plants showed open flowers.

Treatments were:

1. Control — Topped August 12, 1974 with no sucker control used.
2. Systemic — Topped August 12 and sprayed with MH-30 at 1 pint per 1000 plants.
3. Systemic — MH-30 at 1 pint per 1000 plants sprayed on August 6 and topped August 12.
4. Contact — Topped August 12 and Off-Shoot-T applied.
5. Sequential — Off-Shoot-T applied August 6, topped on August 12 and sprayed with MH-30.

There were two harvest dates of August 23, 1974 and September 4, 1974. At the time of harvest suckers were removed from the plot and weighed and counted to determine the effectiveness of sucker control.

Yield, price per pound and acre values were computed for the cured leaf using the standard grades as established by Tobacco Division of the Consumer and Marketing Service of the U. S. D. A.

Results

Rainfall was near optimum during the transplanting period but the period of July and early August was dry. Adequate rains in late August resulted in heavy sucker growth.

The 1974 results are summarized in Table 1 where data for the various suckering agents are combined across the two harvest dates. Best sucker control was obtained with maleic hydrazide applied at topping with 95 per cent control and the contact combined with maleic hydrazide giving 96 per cent control. The practice of using maleic hydrazide before topping gave poorer results with 50 per cent control and the contact resulted in 71% control.

When the early harvest date only was considered sucker control was satisfactory for all treatments. Maleic hydrazide at time of topping gave 89% control, maleic hydrazide applied before topping resulted in 73%, the contact agent gave 86% and contact plus maleic hydrazide also gave 86% control of suckers.

There were no important differences apparent in yield per acre, price per hundredweight or acre values for the different suckering agents tested.

Striking differences were obtained between the two dates of harvesting. The late date, 23 days after topping, compared to 11 days after topping resulted in 158 lbs. greater yield and a $131 higher acre value.

There was no appreciable effect on price per cwt. of the cured leaf by either suckering agents or time of harvest.

Summary

The objective of this research was to compare the following sucker control agents and methods of application; maleic hydrazide at time of topping, maleic hydrazide applied approximately one week before topping, a contact chemical (Off-Shoot-T) at time of topping, a contact approximately one week before topping plus maleic hydrazide at time of topping and a control treatment with no suckering agent used.

Measurement of both sucker numbers and weights of suckers indicated better sucker control for all treatments when compared to the untreated control.

Best sucker control was obtained with maleic hydrazide applied at topping with 95 per cent control and the contact combined with maleic hydrazide giving 96 per cent control. The practice of using maleic hydrazide before topping gave inferior results with only 50 per cent control.

Differences were obtained between the two dates of harvesting. The late date, 23 days after topping, compared to 11 days after topping resulted in 158 lbs. greater yield and a $131 higher acre value.

Table 1. Effects of sucker control treatments and time of harvest on sucker weight, yield, price and acre values of Maryland tobacco. 1974.

Treatment	Yield /Acre Lbs	Price $/Cwt	Acre Value $/A	Suckers % Control	Suckers Weight /Plot Lbs	Suckers Number /Plot
Between Chemical Treatments						
1. Control	1645	86.29	1429	0	6.62	68
2. Maleic hydrazide at topping	1619	86.37	1418	95	0.34	7
3. Maleic hydrazide before topping	1632	86.78	1416	50	3.31	47
4. Contact	1612	86.81	1400	71	1.92	21
5. Contact before topping maleic hydrazide at topping	1555	86.41	1351	96	0.27	3
Between Dates of Harvest						
August 23, 1974	1532	86.64	1337		0.70	16
September 4, 1974	1690	86.62	1468		4.28	42

Performance of Barley Varieties and Breeding Lines in Maryland, 1974

J. W. Johnson
Department of Agronomy

Purpose and Objectives

Variety trials are necessary to evaluate new and presently grown varieties under Maryland's environmental conditions. Advanced breeding lines are also evaluated which have potential as a new variety. The information obtained from these trials provides a dependable guide for varietal selection.

Procedures

In 1974 performance trials were conducted at four locations with varying soil types. Two of these locations are on the Eastern Shore - Queenstown on a Mattapex silt loam and Quantico on a Galestown sandy loam. The other two locations are west of the Bay at Clarksville on a Manor silt loam and Hagerstown on a Hagerstown loam.

Four replications of a randomized complete block design were used at each location. Each plot consisted of two rows, 10 feet long and 1 foot apart. Management practices were used in accordance with those normally accepted for the production of barley. Thirteen standard varieties and three advanced breeding lines were evaluated at all locations.

Results

Barley results are presented in Table 1. The average performance of the varieties for all locations revealed that Rapidan was the superior variety, yielding 84 bushels per acre. Tenn 65-117 and the two Virginia breeding lines Va 70-14-105 and Va 70-44-213, look very promising as new varieties. Tenn 65-117 has been released by the Tennessee Experiment Station in 1975 as Volbar. The yields of barley in certain parts of the state were low due to epidemics of leaf rust and powdery mildew. Barsoy yields were greatly reduced by these two diseases. Barsoy matured about a week earlier than most recommended varieties which makes Barsoy more suitable for double

cropping with soybeans. Lodging was considerably greater west of the Bay than on the Eastern Shore.

Summary

Several breeding lines will be available for farmers in the next two years. Tenn 65-117, Va 70-14-105 and Va 70-44-213 have outstanding potential as varieties in Maryland. The two Virginia lines have excellent disease resistance and standability.

Table I. Average performance of barley varieties for several characteristics in Maryland*, 1974.

Entry	Yield Bu/A	Test Wt. lbs/Bu	Date Headed	Percent Lodging	Height Inches
+Tenn 65-117	86.0	42	May 2	32	41
+Va 70-14-105	84.4	42	May 4	22	38
Rapidan	84.4	40	May 2	42	36
+Va 70-44-213	84.0	42	May 5	23	38
Hanover	76.4	40	May 1	43	37
Knob	72.7	42	May 1	30	37
Jefferson	70.0	43	May 5	21	40
McNair 601	68.9	42	April 29	34	37
Harrison	67.2	45	May 6	15	38
Barsoy	65.6	43	April 24	27	34
Lakeland	62.2	39	May 9	35	36
Kamiak	61.9	39	May 4	43	36
Tschermak	61.4	46	May 5	43	42
Nebar	54.0	41	May 5	54	38
Wong	52.2	39	May 5	49	42
Pennrad	51.8	39	May 7	52	40
Grand Mean	73.8	41.5	May 3	35	38

Lsd = 9.895

* Average of Clarksville, Hagerstown, Quantico, and Queenstown data.

+ Breeding Lines.

Performance of Wheat Varieties and Breeding Lines in Maryland, 1974

J. W. Johnson
Department of Agronomy

Purpose and Objectives

Variety trials are necessary to evaluate new and presently grown varieties under Maryland's environmental conditions. Advanced breeding lines are also evaluated which have potential as a new variety. The information obtained from these trials provides a dependable guide for varietal selection.

Procedures

In 1974 performance trials were conducted at four locations with varying soil types. Two of these locations are the Eastern Shore - Queenstown on a Mattapex silt loam and Quantico on a Galestown sandy loam. The other two locations are west of the Bay at Clarksville on a Manor silt loam and Hagerstown on a Hagerstown loam.

Four replications of a randomized complete block design were used at each location. Each plot consisted of two rows, 10 feet long and 1 foot apart. Management practices were used in accordance with those normally accepted for the production of wheat. Thirteen standard varieties and five advanced breeding lines were evaluated at all locations.

Results

The average performance of the wheat varieties at all locations is presented in Table 1. Many of the wheat yields were low due to the powdery mildew disease. McNair 4823 and Coker 68-15 were the highest yielding varieties. These two varieties are, however, susceptible to powdery mildew. Arthur and Blueboy yields were similar to those of Coker 68-15. Arthur has excellent disease resistance and test weight. The Virginia breeding line, Va 70-50-22, was the highest yielding entry with 60 bushels per acre; however it was not significantly different from Va 66-54-6. Va 66-54-6, a possible new release, yielded 56 bushels per acre.

Summary

Several breeding lines from Virginia have potential as new varieties for Maryland.

Table I. Average performance of wheat varieties for several characteristics in Maryland*, 1974.

Entry	Yield Bu/A	Test Wt. lbs/Bu	Date Headed	Percent Lodging	Height Inches	Percent Mildew
+Va 70-52-22	60.1	56	May 14	1	36	trace
+Coker 72-12	56.6	57	May 13	4	36	8
McNair 4823	56.4	60	May 14	0	37	46
+Va 66-54-6	55.6	60	May 14	21	42	10
McNair 1587	54.9	57	May 12	8	36	10
Va 68-24-42	54.2	57	May 14	0	37	0
Coker 68-15	52.3	60	May 11	7	36	40
Holley	50.6	58	May 9	33	42	0
McNair 1813	49.7	58	May 11	18	38	4
Blueboy	49.0	56	May 13	3	39	36
Arthur	48.8	59	May 11	12	38	2
McNair 701	48.5	56	May 9	22	34	4
+Coker 72-5	48.4	58	May 10	32	40	17
Oasis	48.0	59	May 11	17	38	trace
Arthur 71	46.8	59	May 11	12	37	1
Redcoat	44.5	59	May 15	0	45	15
Abe	44.4	59	May 11	9	35	trace
Blueboy II	42.0	57	May 13	2	39	50
Grand Mean	52.6	58	May 12	11	38	14
Lsd = 6.195						

* Average of Clarksville, Hagerstown, Queenstown, and Quantico data.

+ Breeding lines.

Double Cropping Soybeans After Wheat and Barley

J. W. Johnson, F. R. Mulford, L. H. Smith and W. J. Varano
Department of Agronomy

Purpose and Objectives

This study was conducted with two primary objectives: (a) to compare soybeans planted after early and midseason maturing barley and wheat varieties, (b) to determine the feasibility of double cropping in Maryland compared to no-tillage corn under three fertility levels.

Procedures

Two barley varieties, Barsoy (early) and Rapidan (midseason) and three wheat varieties, Coker 68-15 and Abe (two early season) and Blueboy (midseason) were harvested and followed with a soybean crop. The soybean variety, Essex, was planted no-tillage in 20 inch rows after each small grain variety was harvested. Pioneer 3369A was the corn variety planted no-tillage into rye stubble for comparison with the other double crop systems.

Three fertility levels, low, medium and high, were applied to each small grain variety. Each fertility level represented a fall application of 10-40-40. The low, medium and high fertility levels received an additional topdressed application in the spring of 20-40-40, 40-80-80 and 80-160-160, respectively. Corn received an additional 40, 60 and 80 lbs. of nitrogen for the low, medium and high fertility levels, respectively.

Results

Rapidan yielded slightly more than Barsoy in 1973 (Table 1). The best yielder of the wheat varieties was Coker 68-15. Soybean yields showed no differences between early (Barsoy) and midseason (Rapidan)

barley varieties. However, soybean yields were much higher after barley than after wheat in 1973.

The dollar return per acre was considerably less for corn than for the double cropping systems (Table 2). Coker 68-15 and Abe grossed the highest dollar return per acre. The gross return per acre was considerably higher for the double cropping systems of soybeans followed after wheat than after barley; even though, the soybean yields were higher after barley. In 1974, Rapidan out-yielded Barsoy (64 vs. 30 bushels per acre). Coker 68-15 yielded 29.8 bu/acre which was slightly more than Abe or Blueboy with yields of 27.7 and 24.8 bu/acre, respectively.

Summary

The double cropping of soybeans after wheat or barley has become popular in Maryland. The major cause of low soybean yields in double cropping soybeans is lateness of planting. Early varieties of small grains, particularly wheat, are essential. Barley is usually grown instead of wheat based on the earliness of harvest of barley, approximately two weeks earlier than wheat. However, the total gross return per acre was higher with soybeans followed after wheat than after barley due to the difference in the value of the small grains. The double cropping of soybeans after small grains looks very competitive to no-tillage corn.

Table 1. Production Levels of Five Double-Cropping Combinations on the Eastern Shore, 1973

Small Grain Variety	Yield, Bu/A	
	Small Grain	Essex Soybean After Small Grain
Barsoy	49.7	48.3[2/]
Rapidan	56.2	47.9[2/]
Abe	54.7	44.9[3/]
Blueboy	52.2	41.1[3/]
Coker 68-15	58.6	44.6[3/]

1/ Planted in No-Till 20" rows at 5 seeds/foot.

2/ Planted 6/14 at Quantico and 6/27 at Wye Institute.

3/ Planted 7/10 at Quantico and 7/12 at Wye Institute.

Table 2. Gross Returns of Five Double Cropping Combinations and Corn at Two Locations on the Eastern Shore, Maryland, 1973

Small Grain Variety	Price/Bu at Harvest	Gross Small Grain Return	Gross Soybean[1/] Return	Total Gross Return/Acre
Barsoy	$1.50	$ 74.55	$241.50	$316.05
Rapidan		84.30	239.50	323.80
Abe	2.51	137.30	224.50	361.80
Blueboy		131.02	205.50	336.52
Coker 68-15		147.09	223.00	370.09
Corn[2/]				236.71

1/ Essex soybeans were planted in 20" no-till rows. November 1 price of $5.00/bushel was used.

2/ Pioneer 3369A was planted in 30" no-till rows in early May. Price of $2.35/bushel was used for corn.

Testing Lodging Resistance of Maryland Tobacco Varieties with a Wind Making Machine

C. G. McKee and M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

Previous work with selected Maryland tobacco varieties indicated that a wind making machine could be used to test lodging resistance. Thus, in this season all presently released Maryland tobacco varieties were tested for lodging resistance. Lodging has been a particular problem for growers who plant Md. 609. This variety accounts for over 50% of Maryland tobacco acreage and farmers who do not want to plant Md. 609 because of lodging problems need to know what varieties have the best lodging resistance.

Procedure

Maryland tobacco varieties Md. 10, Md. 64, Md. 609, Md. 59, Md. 872, and Md. 201 were planted in a field test on a Monmouth fine sandy loam soil. Single row plots were used with six replications. When the plants had started to flower, the plots were irrigated with approximately $1\frac{1}{2}$" of water. A John Bean Rotomist 100 mist blower sprayer was used to provide "wind" to blow directly into the single row plots. Estimates of the angle of lean of the first four individual plants in each plot were then made within 24 hours of treatment.

Results

The tobacco plants leaning less than 15 degrees from perpendicular after treatment were not considered to be lodged enough to be of any problem at harvest. Table 1 shows the percentage of plants of the varieties that were leaning 15 degrees or more after the wind treatment. Md. 64 showed the highest resistance to lodging followed closely by Md. 201, a

Table 1. Percentage of tobacco plants leaning 15 degrees or more after blowing with artificially produced wind, 1974.

Variety	% Leaning over 15 degrees
Maryland 10	28
Maryland 609	37
Maryland 872	28
Maryland 201	25
Maryland 59	38
Maryland 64	22
L.S.D. (.05)	5

newly released variety developed from a cross using Md. 64. Md. 10 and Md. 872 were similar in lodging resistance and this level is satisfactory for most field conditions. Md. 609 and Md. 59 showed the poorest resistance to lodging and this is consistent with on-farm observations.

Summary

The results from this study will provide some information to growers who are interested in lodging resistance as a consideration in variety selection. The newly released varieties Md. 872 and Md. 201 both have better lodging resistance than Md. 609 or Md. 59.

Irrigation with Maryland Tobacco

C. G. McKee
Department of Agronomy

Purpose and Objectives

Presently between 15 and 20% of the Maryland tobacco crop can be irrigated if needed. Supplemental water is not necessary every year, but in some seasons the crop value can be doubled. Thus, the objective of this experiment is to gather long term data on the benefit of irrigation to the production of Maryland tobacco and to determine if there is a differential variety response to irrigation.

Procedure

The experiment was a split plot design. Main plots were varieties — Md. 10, Md. 609, Md. 64, Md. 872, Md. 201, and breeding line J-1F-1. There were six replications for a total of 72 plots.

The test was located at the University of Maryland Tobacco Experimental Farm. The soil was a Monmouth fine sandy loam. The fertilizer application was 90 lbs. N, 120 lbs. P_2O_5 and 180 lbs. K_2O equivalent per acre.

Water was applied to the plots requiring irrigation when the plants started to show moisture stress in the heat of the day. A Skinner overhead pipe system was used for irrigation.

Fifteen plants were harvested and cured from each plot. The cured plants were stripped into farmer grades, weighed, U.S.D.A. grades assigned and priced according to grade. Yield per acre and value was then calculated. A representative sample of the cured leaves from the whole plant was taken for chemical analysis and a leaf from the mid portion of the stalk of each plant was saved for leaf burn and filling capacity tests.

Plants were transplanted into the field on June 13. One irrigation of about 2 inches of water was applied on July 17-19. The plants were topped on August 12 and harvested on August 21.

Results

The results for irrigation on tobacco in 1974 are given in Table 1. Irrigation improved yield by an average of 274 pounds per acre, price per pound by an average 3.5¢, and dollar value by an average of $280 per acre. The season was dry in the mid-July period and this is a very critical period for Maryland tobacco. Md. 872 gave the greatest response to irrigation with an increase of 350 pounds per acre. Md. 609 gave the lowest increase with 202 pounds per acre.

Summary

The 1974 season was dry in the mid-July period. One irrigation of approximately 2 inches of water during this period increased yield and quality for an overall average increase of $280 per acre when compared with nonirrigated tobacco. All varieties and the breeding line tested responded to irrigation with yield increases ranging from 202 pounds per acre for Md. 609 to 325 pounds per acre for Md. 872.

Table 1. Summary of tobacco irrigation test — 1974.

Variety	Yield/Acre lbs.	Cents/lb.	$/Acre
	Irrigated		
Md. 609	1666	84.1	1403
Md. 10	1833	82.7	1516
Md. 64	1961	80.6	1580
Md. 872	1974	84.5	1669
Md. 201	1956	83.5	1633
B.L. J-1F-1	1918	80.0	1537
	Not Irrigated		
Md. 609	1464	82.4	1205
Md. 10	1518	79.4	1205
Md. 64	1693	76.8	1301
Md. 872	1624	81.5	1324
Md. 201	1707	77.3	1321
B.L. J-1F-1	1661	77.6	1301
Ave. Irrigated	1885	82.6	1556
Ave. Not Irrigated	1611	79.1	1276
Advantage of Irrigation	+274 lbs.	+3.5¢	+$280

Low Plant Population Studies with Maryland Tobacco

C. G. McKee
Department of Agronomy

Purpose and Objectives

Tobacco production requires about 230 man-hours of labor per acre. This is because the individual plants are handled many times: pulling from seedbed, transplanting, topping, harvesting, and stripping. Earlier studies with population rates ranging from 6223 to 9680 plants per acre showed that total yield per acre, although often greater at the higher plant population levels, was not proportional to the number of plants per acre. Thus, as plant populations were increased, yield per plant was reduced. The purpose of this test was to study lower than normal plant populations with the idea of determining maximum or optimum levels of production per plant. This would help growers get maximum production per hour of labor.

Procedure

Four plant population levels, 6223, 4978, 4149, and 3556 plants per acre at 3 nitrogen rates, 50, 70, and 90 pounds per acre were studied. The test was a split-plot design with nitrogen rates as main plots and plant populations as the split plots. Four replications were made and Maryland 872 variety was used. The test was irrigated as needed to maintain optimum growing conditions. At harvest, the sticks of green tobacco were weighed to determine green weight per plant. After curing, the plots were stripped, weighed, graded and priced. Yield per acre and dollar value, yield per plant and % yield cured leaf of green weight were computed.

Although not an integral part of the test, 36 non-competitive plants were grown to try to determine the maximum potential production of a plant. These plants were spaced 7 feet on centers. Twelve plants were grown at each of the 3 nitrogen rates, 50, 70, and 90 pounds per acre equivalent.

Results and Discussion

The results for the 1974 season of the low tobacco plant population study are in Table 1. None of the plant population rates tested approached the yield per plant level obtained from the non-competitive plants. The lower plant population levels decreased yield per acre and dollar return, but increased green weight per plant, cured leaf per plant, and the % cured leaf of the green weight.

The 3556 plant population rate yielded 1798 lbs. per acre, the 6223 plant population rate 2209 lbs. When comparing the two population rates, 2667 more plants and 9566 more pounds of green weight were handled at the higher rate for 411 additional pounds of tobacco. If the 6223 plants had been planted at the 3556 rate per acre, yield would have been 3146 pounds or 937 more than at the 6223 plant per acre rate while handling 9023 more pounds green weight.

One of the more interesting features uncovered in this first year of the study is that there is a higher % yield of cured leaf to green weight handled in the low plant population levels. This trend seemed to show a dividing point between the higher two and lower two population rates. The 4978 and 6223 plant rates averaged 6.58% return of cured leaf to green weight whereas the 3556 and 4149 plant rates averaged 7.36% return or about 12% more.

The problem with the lower plant population levels is the higher green weight per plant at harvest. The larger plants are more difficult to handle and less plants can be speared per stick. However in the other hand operations, the large plant should make little if any difference.

Summary

The low plant population study with Maryland tobacco was initiated during the 1974 season. The first year's results show that lower plant population levels decrease yield per acre, but increase yield per plant. Green weight per plant is also increased with lower plant population levels, and this may prove to be a limiting factor as long as the crop is hand cut and speared. The chemical analyses of the tobacco samples will also be a very important part of this work, but they have not been completed at this time. This test will be continued in 1975.

Table 1. Summary of low plant population study with Maryland tobacco — 1974.

Nitrogen rate (lbs/A)	Plant population per acre	Yield/Acre lbs.	Cents/lb.	$/Acre	Green Wt./Plant lbs.	Cured Leaf Wt./Plant lbs.	% Cured Leaf of Green Wt.
50	3556	1807	87.5	1582	6.99	.51	7.32
	4149	1849	88.6	1639	6.23	.44	7.12
	4978	2031	87.3	1774	6.22	.41	6.62
	6223	2200	85.5	1878	5.63	.35	6.30
	Ave.	1971	87.2	1718	6.26	.43	6.84
	Non-competitive				8.06	.76	9.50
70	3556	1803	87.8	1583	6.82	.61	7.44
	4149	1923	87.6	1682	5.92	.46	7.82
	4978	2124	88.0	1867	6.40	.43	6.73
	6223	2143	88.6	1898	5.17	.35	6.71
	Ave.	1998	88.0	1757	6.07	.43	7.17
	Non-competitive				8.94	.81	9.10
90	3556	1784	87.6	1562	7.11	.50	7.05
	4149	2047	86.1	1764	6.63	.49	7.38
	4978	2191	88.0	1927	6.56	.44	6.72
	6223	2286	88.0	2013	5.75	.37	6.40
	Ave.	2077	87.5	1816	6.28	.44	6.97
	Non-competitive				8.39	.76	9.10
Average	3556	1798	87.6	1576	6.97	.51	7.27
	4149	1939	87.4	1695	6.26	.46	7.44
	4978	2115	87.7	1856	6.39	.43	6.69
	6223	2209	87.4	1929	5.52	.36	6.47

Comparison of Double-Crop, No-Tillage Corn, Sorghum, and Sunflowers for Silage

C. C. Sheaffer, J. H. McNemar, and N. A. Clark
Department of Agronomy

Purpose and Objectives

Sunflowers are unable to compete with corn or sorghum as suppliers of silage on a single crop basis; however, due to their fast maturity, drought and cold tolerances, sunflowers might find use in a multiple cropping system following a cereal harvested as silage or a short season barley harvested for grain. In such a situation, soil moisture is depleted and, if summer rainfall is sparse, most crops are unable to make profitable growth.

Although extensive research was once done on the use of sunflowers for silage as a full season crop, sunflowers have not been evaluated for use in double cropping systems as suppliers of silage. The objectives of this study were: (1) To evaluate the potential yield value of sunflowers planted in a double cropping system. (2) To examine factors affecting the feeding value of sunflowers.

Procedure

Three sunflower varieties -- Greystripe, Mingren, and Iosanka -- were planted in stubble on July 12, two weeks after barley harvest, using a four-row no-till corn planter. The soil was a Manor silt loam with a pH of 6.2, and MgO, P_2O_5, and K_2O were all in the high range. A short season sorghum (T-E Bird-A-Boo) and field corn (Minn 621) were also planted in order to allow a comparison with sunflowers. The study was located at the Agronomy-Dairy Forage Research Farm.

The experimental design was a randomized complete block with four replications. The seed spacing for sunflowers and sorghum averaged four inches apart in 30-inch rows for a population of approximately 52,000 plants per acre. However, the stands of sunflowers were quite variable due to mechanical

inadequacies of the planter. The corn population was approximately 23,000 plants per acre.

Harvests were made shortly after each variety reached the flowering stage. The corn and sorghum did not mature before the first frost. Wet weights were taken and five plants were sampled for dry matter determination.

Results

Average yields are shown in Table 1. No significant differences in yield existed. Greystripe was the highest yielding sunflower variety and also out-yielded corn and sorghum.

Summary

The sunflower variety Greystripe out-yielded other sunflower varieties as well as sorghum and corn in this test.

Table 1. Dry matter yields of sunflowers, sorghum, and corn. 1974.

Crop	Yield (ton/acre)
Greystripe Sunflowers	3.49 a 1/
Corn	3.08 a
Sorghum	2.99 a
Mingren Sunflowers	2.76 a
Iosanka Sunflowers	2.48 a

1/ Means followed by the same letter are not significantly different at the .05 level of probability according to Duncan's Multiple Range Test.

Population Management Studies with Sunflower Silage

C. C. Sheaffer, J. H. McNemar, and N. A. Clark
Department of Agronomy

Purpose and Objectives

Sunflower silage has shown promise as a summer silage crop in a double crop sequence following a winter small grain. In a dry, hot season, sunflowers can compete well with corn or soybeans. The objective of this study was to evaluate populations under two fertilizer levels using confectionary, birdseed, and oil types of sunflowers. In a companion study, methods of seed placement and spacing of plants expanded the population aspect of the first study.

Procedure

Two experiments were conducted at the Agronomy-Dairy Forage Research Farm as follows:

Experiment I. This study was conducted on a Chester loam which had a pH of 6.3. MgO was in the high range while P_2O_5 and K_2O were medium. Several sunflower varieties were planted on June 19 at three population levels on soil fertilized at rates of 50-100-100 and 100-200-200 lbs/acre N-P_2O_5-K_2O (Table 1). The experiment was conducted as a split-split design with three replications. Fertility levels were applied to the whole plots with varieties as sub-plots. Each variety was planted at three population levels arranged at random. Sunflowers were hand planted in 36-inch rows with spacings of 1.5, 3.0, and 6.0 inches in the row in order to obtain the population levels shown in Table 1.

Sunflowers were harvested following complete flowering. Wet yields were obtained and five plants were sampled for dry matter determination. Samples were dried, ground, and analyses conducted for *in vitro* dry matter digestibility (IVDMD), acid detergent fiber (ADF), and lignin according to the procedures of Goering and Van Soest. Kjeldahl determination for total nitrogen

was also conducted.

Experiment II. This study was established on a Chester silt loam with a pH of 6.5. MgO, P_2O_5, and K_2O were all in the high range. Sunflowers were planted on June 20. The experimental design was a split-plot with three replications. Varieties were whole plots, and four populations and spacings were randomly arranged in the sub-plots. The varieties were Greystripe and Mingren. Populations and spacings were as follows:

Population plants/acre	Spacings
140,000	15-inch rows, 3-inch seed spacing within row
70,000	30-inch rows, 4 seeds (hill drop) at 12-inch spacing within row
140,000	30-inch rows, 4 seeds (hill drop) at 6-inch spacing within row
70,000	30-inch rows, 3-inch seed spacing within row
140,000	30-inch rows, 1.5-inch seed spacing within row

Harvest of varieties was timed so that each would be removed after just flowering. Wet yields were obtained and five plants sampled for dry matter determination. Due to the similarity of 1973 and 1974 experiments, a combined analysis of variance was conducted.

Results

Experiment 1. Sunflower yields were significantly affected only by varieties planted (Table 2). The late maturing confectionary variety, Greystripe, had an average dry matter yield per acre of 3.70 tons which was over a ton higher than the average yield of the oil variety, Iosanka.

Although a trend existed toward increased yields at higher populations, no significant differences were found. This differs from previous work at this station which indicated significantly higher yields at higher populations. Greystripe had the highest yield when planted at a population of 69,696 plants per acre. Peredovic and Iosanka yields both increased as population increased, but Mingren had its highest yield at a population of 34,848 plants per acre. Planting sunflowers at a population of 139,392 plants per acre resulted in plants with thin, weak stalks. At this population, lodging was severe and harvesting difficult.

As shown in Table 3, sunflowers harvested at the flowering stage had high lignin and acid detergent fiber levels. These represent relatively indigestible portions of the forage and have a negative effect on *in vitro* dry matter digestibility.

There was a significant difference in varietal forage quality. Greystripe and Mingren had a lower forage quality than Peredovic and Iosanka. The late maturing Greystripe had the highest levels of ADF and lignin and a significantly lower IVDMD. Peredovic had the lowest ADF and lignin content and the highest IVDMD.

Increases in the plant population per acre resulted in significant increases in ADF and lignin (Table 4). Although IVDMD was decreased at higher populations, the reduction was not significant. Kjeldahl nitrogen values of the forage did not vary significantly due to the treatments in the experiment. An average value of 12.20 percent was found.

Experiment II. Analysis of 1973 and 1974 yield data for the sunflower varieties Greystripe and Mingren planted in several spacing arrangements showed Greystripe to have significantly higher yields per acre than Mingren (Table 5). Planting of sunflowers in 15-inch rows with within-row spacing of three inches produced significantly higher yields per acre than all other treatments. However, as in Experiment I, the high population resulted in a high percentage of lodging. Yields for hill-dropping of sunflowers were not significantly higher than conventionally planted sunflowers.

Summary

In both experiments, Greystripe was consistently the highest yielding sunflower variety. Increasing populations generally produced higher dry matter tonnage, but as yields increased, the lodging problem also became more severe. Sunflower silage, although high in lignin and low in dry matter, had an average IVDMD of 66.00 percent over all experiments.

Table 1. Sunflower varieties and populations. Experiment I. 1974

Population plants/acre	Varieties	Type
34,848 (Low)	Iosanka	oil
69,696 (Medium)	Peredovick	oil
139,392 (High)	Greystripe	confectionary
	Mingren	birdseed

Table 2. Dry matter yields of four sunflower varieties at three populations. Experiment I. 1974.

Variety	Population			Average
	Low	Medium	High	
	tons/acre			
Greystripe	3.55 a [1/]	3.88 a	3.65 a	3.70 a
Peredovick	2.85 a	2.87 a	3.25 a	2.99 bc
Mingren	3.30 a	2.92 a	3.10 a	3.10 b
Iosanka	2.43 a	2.61 a	2.91 a	2.65 c
Average	3.03 a	3.07 a	3.23 a	3.11

1/ Means followed by the same letter for varieties within a population, for populations over all varieties, and for varieties over all populations are not significantly different at the .05 level of probability according to Duncan's Multiple Range Test.

Table 3. Acid detergent fiber (ADF), lignin, and *in vitro* dry matter digestibility (IVDMD) for four sunflower varieties. Experiment I. 1974

Variety	ADF	Lignin	IVDMD
	%	%	%
Greystripe	53.10 a[1/]	17.10 a	64.76 b
Peredovick	46.82 c	15.31 b	69.46 a
Mingren	52.00 ab	16.25 a	67.48 a
Iosanka	50.05 b	16.62 a	68.96 a

1/ Means within a column followed by the same letter are not significantly different at the .05 level of probability according to Duncan's Multiple Range Test.

Table 4. Acid detergent fiber (ADF), lignin, and in vitro dry matter digestibility (IVDMD) of sunflowers planted at three popu ations. Experiment I. 1974.

Population plants/acre	ADF	Lignin	IVDMD
	%	%	%
34,848 (Low)	48.67 a[1/]	15.85 b	67.47 a
69,696 (Medium)	50.69 ab	16.37 ab	67.42 a
139,392 (High)	52.13 a	16.74 a	65.89 a

1/ Means within a column followed by the same letter are not significantly different at the .05 level of probability according to Duncan's Multiple Range Test.

Table 5. Dry matter yields of Greystripe and Mingren sunflowers planted at five spacings. Experiment II. Average for 1973-1974.

Variety	Spacing (inches)					Average 2/
	15 x 3	30 x 6 (H4)	30 x 1.5	30 x 12 (H4)	30 x 3	
	tons/acre					
Greystripe	4.60 a 1/	3.70 b	3.59 b	3.69 b	3.72 b	3.86 X
Mingren	2.88 a	2.84 a	2.84 a	2.84 a	2.73 a	2.83 Y
Average 2/	3.74 A	3.67 B	3.22 B	2.27 B	3.22 B	

1/ Means followed by the same letter within a variety are not significantly different at the .05 level of probability.

2/ Means followed by the same letter are not significantly different at the .05 level of probability.

The Response of Alfalfa to Fertility, Irrigation, and Cutting Management

J. H. McNemar and N. A. Clark
Department of Agronomy

Purpose and Objectives

Alfalfa is unquestionably the leading quality hay crop in the Northeast. Alfalfa acreage is presently increasing, partly due to the availability of improved varieties with higher yield potential than the older cultivers. Although varietal improvement has made significant progress and fertilization practices have changed, other alfalfa management practices have not changed in the last fifteen years.

The overall objective of this study is to update alfalfa management. This is to be accomplished through the following specific objectives: (1) To compare, in terms of yield and stand persistence, a reliable old alfalfa variety with a superior new variety under: (a) irrigated and non-irrigated conditions, (b) current soil test recommendations for fertilizer and rates of one-half and double this recommended rate, (c) four levels of intensity in cutting management. (2) To compare yield productivity with nutrient digestibility under the different management systems.

Procedures

The experimental planting was made in the fall of 1973 on a Chester loam soil. Soil test results showed a pH of 6.8, and MgO, P_2O_5, and K_2O were medium. The varieties established were Williamsburg and WL 311, and harvests were conducted during the 1974 growing season. Due to the fact that the stand was not established until late in the previous fall, it was decided that severe early spring management would reduce the stand and defeat the purpose of the study. Therefore, the first harvest on all plots was delayed until half-bloom to allow sufficient growth to enhance the survival of the stands. Following the initial harvest at the end of May, half of the plots were harvested every 30

days and the other half every 40 days. All plots were allowed at least 30 days regrowth before a frost harvest on October 4. There were five harvests for the 30-day plots and four for the 40-day plots. Following the first harvest, the recommended soil test application of fertilizer, 0-45-90, was applied to the appropriate plots. The high fertility plots received 0-90-180 and the low fertility plots 0-22.4-45. Beginning July 1, the irrigated plots received one inch of water per week if this amount was not supplied by natural rainfall.

Results

Yields are shown in Table 1. These data have not yet been analyzed statistically, but it appears that the 30-day harvest resulted in significantly lower yields of dry matter than the 40-day schedule. Irrigation, fertility, and varieties do not appear to be significant. Chemical analyses for quality have not yet been completed.

Summary

An alfalfa management experiment was established in the fall of 1973 and subjected to management treatments in 1974. Of the factors studied -- irrigation, fertility, and cutting frequency -- only cutting frequencies gave measurable differences in yield. In subsequent years, other factors will no doubt also be significant.

Table 1. Dry matter yields of Williamsburg and WL 311 alfalfa under irrigated and non-irrigated conditions, harvested at 30- and 40-day intervals, and fertilized at recommended soil test levels and one-half and double these rates. Agronomy-Dairy Forage Research Farm, Clarksville, Maryland. 1974

Irrigated		Non-Irrigated
5.63		5.58
	30-Day Harvest	
5.56		5.48
	WL 311	
5.71		5.72
	Fertility	
5.57	Low	5.66
5.73	Medium	5.63
5.82	High	5.87
	Williamsburg	
5.41		5.25
	Fertility	
5.46	Low	5.30
5.40	Medium	5.19
5.38	High	5.25
	40-Day Harvest	
5.70		5.68
	WL 311	
5.86		5.87
	Fertility	
5.94	Low	5.67
5.94	Medium	5.90
5.71	High	6.03
	Williamsburg	
5.54		5.50
	Fertility	
5.34	Low	5.54
5.56	Medium	5.60
5.73	High	5.36

Response of Corn and Soils to Long-Term No-Tillage and Subsoil Practices

F.P. Miller
Department of Agronomy

Purpose and Objectives

The purpose of this continuing study is to evaluate the response of corn to several methods of soil preparation and tillage. The tillage practices include subsoiling at three spacings, plow-planting and no-tillage planting under several conditions, viz., no preparation, disking ahead of the no-tillage planter, and plowing - disking ahead of the no-tillage planter.

Procedures

This study is located at the Wye Institute on the Bertie silt loam (somewhat poorly-drained) and Mattapex silt loam (moderately well-drained) soils. Four replications were used throughout and the plot size was 50 x 20 feet. The corn variety was Pioneer 3369A planted in 30 inch rows on May 9. The no-tillage corn (including a check, disk-plant, and plow-plant treatment) was planted with a modified four-row International Harvester planter, and a four-row John Deere planter was used for the conventionally planted corn (including a check, plow-plant, and previously subsoiled treatments).

All plowing and disking was done on the day of planting. The plots to be planted with the no-tillage planter were either left untreated (no-till), disked only, plowed only (plow-plant), or plowed and disked (check). The plots to be planted with the J.D. conventional planter were either plowed and disked (check and previously subsoiled plots), or plowed only (plow-planted).

Fertilizer was broadcast on all plots (including the no-till plots) prior to plowing at the rate of 165-110-110 (lbs per acre of $N-P_2O_5-K_2O$). No fertilizer was applied in the row by the planter.

A combination herbicide was applied to all plots on May 9 at the rate of 1.5 pounds AI/A of atrazine (AATREX) and 1.5 pounds AI/A of simazine

(PRINCEP). Although no cover crop was planted on the no-tillage plots, a heavy infestation of chickweed was present along with the residue and corn stover from the previous year's crop. These no-tillage plots, in addition to the aforementioned herbicide treatments, received an application of paraquat at the rate of 0.5 pound (one quart) per acre on May 3. The no-tillage corn was planted into the previous year's stover and indigenous weed cover.

On September 19, 1974, soil samples were taken from each of the four replicates of the no-till treatments and check plots for analysis. Eight soil samples were withdrawn from each replicate and mixed for a composite sample. Composite samples were collected from 5 depths (surface, 2, 4, 6 and 8 inches) on each replicate. Composite samples were collected from two reps at the 10 and 15 inch depth.

Results

The results for the 1974 test on the previously subsoiled plots and the plow-plant treatments are presented in Table 1. The data also include the yields for the period 1967-73.

The yields from the previously subsoiled plots were similar to the check. Yields from the plots subsoiled at the 80 inch spacing were low due primarily to reduced plant populations in the replications caused either by planter misses or bird damage. The 1973 yields from all subsoiled plots averaged 15 bu/ac less than the check plots whereas there was only an eight bu/ac average yield reduction in 1974. Most of the yield variation between the subsoiled and check plots over the past eight years has not been significant. However, there have been certain years when the yields from the subsoiled plots have been significantly less, indicating that subsoiling these silt loam soils has produced yield-depressing effects, probably through deterioration of tilth and compaction. The eight year average yield

reduction of all three subsoil spacings is 12 bu/ac.

The plow-plant treatment still appears to be an alternative on these silty soils. After seven years of this continuous treatment (Table 1), only slight yield reductions have been noted when compared to the check. This treatment will be continued.

The no-tillage treatment data are presented in Table 2. The 1974 no-tillage yields were essentially the same as the conventionally planted check or the treatment where only disking was used. After six years of continuous no-tillage corn production, there has been no difference in yield on these plots when compared to conventionally planted corn. For maximum no-tillage production it appears that a fairly dense mulch of the previous year's corn stover and a lush chickweed cover are necessary ground cover conditions at the time of planting. Under these ground cover conditions, therefore, it appears that no-tillage corn production on these soils is feasible without a planted cover crop. The most noticeable yield reductions have occurred on those plots where the mulch cover has been sparse.

Fall panicum is still the dominant weed in the no-tillage plots but it does not pose a major problem at this time. The herbicide combination of atrazine and simazine appears to keep it under control until the crop is made.

One of the objectives of this study is to evaluate the effect of the conventional and no-tillage corn production systems on the chemical environment of the soil profile. Continuous corn production under the no-tillage system requires that lime and fertilizer be applied to the soil surface without incorporation through tillage. Eventually, this practice results in a buildup of nutrients near the soil surface. After six years, the no-tillage corn yields (as compared to conventionally tilled corn) do not appear to be retarded by this situation. The nutrient gradient under both tillage systems has been monitored since 1970 to record the changes in the chemical environ-

ment of the soil.

Table 3 contains soil test results from incremental soil samples under the conventional and no-tillage plots. The nutrient data are expressed as pounds per acre and have not been corrected for the fractional portion of the acre-furrow slice represented by each increment. The data should be considered as concentrations (pp2m) and are not cummulative with depth.

These plots were limed in April 1973 at the rate of 1.5 tons per acre. The pH of the no-tillage plots at the surface is still higher than the plowed plots despite two years of surface application of nitrogen fertilizer.

As expected and as shown in previous reports of this work (Crops and Soils Research, 1973, Dept. of Agronomy), the nutrient gradient under the no-tillage system is very steep with the nutrients concentrated at or near the surface. Except for the high concentration of potash in the surface sample, the nutrient distribution under the conventional corn plots is more uniformly distributed as would be expected when these soils are mixed annually through plowing and disking.

At first glance, it may appear that the no-tillage plots contain more nutrients because of the consistently high concentration of the surface sample. It must be noted, however, that this surface sample represents a very small portion of the total plow layer The concentration gradient with soil depth drops off very rapidly under the no-tillage plots. Therefore, the higher nutrient levels at the surface under the no-tillage system are probably offset by the higher concentration of nutrients in the lower portion of the plow layer under conventionally planted corn. Thus, the plow layer volume of the surface sample under the no-tillage system should not be weighed the same when comparing this depth increment sample with the conventionally treated plots which have been mixed.

These data continue to substantiate the fact that continuous no-tillage

corn will result in concentration of lime, P_2O_5 and K_2O in the upper portion of the root zone. The different moisture and temperature regime under no-tillage crop production possibly offsets any deleterious effects this concentration might have on corn yields. This situation will continue to be monitored.

Summary

After six years of subsoiling these soils, no beneficial effects have been noted as measured by corn yields. In fact there has been a trend toward reduced yields during the six years that subsoiling was practiced (1967-72). Although the plots have not been subsoiled since 1972, the corn yields were still depressed for 1973 (15 bu/ac average decrease from the check) and 1974 (8 bu/ac average decrease from the check), indicating the deleterious after-effects of probably compacting these silt loam soils through subsoiling.

No-tillage corn production on these soils without a planted cover crop appears to be feasible as long as a suitable mulch composed of indigenous weeds and previous year's crop residues covers the soil. After six years of corn production, observations and yield data have indicated that the no-tillage plots have yielded as well as the conventionally planted plots. Although the fertilizer nutrients are concentrating near the surface after six years without plowing or cultivating the no-tillage plots, corn production does not seem adversely affected when compared to the conventionally treated corn.

Table 1. Average corn yields for the period 1967-74 for four soil management treatments - Wye Institute, Maryland

Treatment	Average yield (bu/acre)								
	1967	1968	1969	1970	1971	1972	1973	1974*	Mean
Check	112	118	130	122	125	112	106	127	119
Subsoiled 22 inches	112	98	113	113	106	98	90	120	106
Subsoiled 44 inches	115	116	123	97	115	94	90	126	110
Subsoiled 80 inches	115	105	103	101	97	93	88	112	102
Plow-planted	-	98	120	117	114	105	98	114	109

*The 1973-74 plots were not subsoiled, but were recorded separately to determine any after-effects of the previous six years subsoiling.

Table 2. Average corn yields for no-tillage treatments as compared to conventional planting - Wye Institute, Maryland.

Treatment	Average yield (bu/acre)						
	1969	1970	1971*	1972	1973	1974	Mean
Check; plowed,disked	125	97	88	94	98	119	104
Disked only	131	118	65	90	91	114	102
No-tillage (stover)	136	102	71	100	86	123	103

*In 1971, a rye cover crop was planted in the fall of 1970. To simulate no-tillage planting with no cover crop, the rye was cut and removed. The corn was then planted into the rye stubble. Where the corn was planted into the rye cover crop, the yield averaged 112 bu/acre. The low yields resulted primarily from poor stands caused by the no-tillage planter being adjusted for planting in a cover crop.

Table 3. Soil test results on incremental depths under conventional and no-tillage corn after 6 years (Sampled 9-19-74).

Depth (in.)	pH			P_2O_5			K_2O		
	Conv.	No-till	Bayes LSD.05	Conv.	No-till	Bayes LSD.05	Conv.	No-till	Bayes LSD.05
				lbs/ac					
Surface	5.6	6.2	.19	216	750	41	325	292	N.S.
2	5.4	5.8	N.S.	225	495	148	194	189	N.S.
4	5.5	5.3	N.S.	247	202	58	153	121	N.S.
6	5.5	5.8	.29	188	135	62	150	98	58
8	5.5	6.0	.22	166	77	25	129	74	45
10	5.8	6.0	*	88	85	*	138	69	*
15	6.0	6.1	*	25	8	*	99	38	*
Ave*	5.5	5.8	.11	184	295	71	176	143	N.S.

*The 10 and 15 inch depths included samples from only two reps. Therefore these two depths were not analyzed. The averages, likewise, do not include the 10 and 15 inch depth figures.

Effects of Different Sources of Chloride on the Uptake of Chloride and the Balance of Nutrients in Maryland Air-cured Tobacco

Charles L. Mulchi and Wilbur W. Newcomb
Department of Agronomy

Purpose and Objectives

In our efforts to evaluate the response of Maryland tobacco to chloride released from cooling towers operating on brackish water, information was needed regarding: (1) the uptake of chloride by tobacco plants from aerial drift as well as from soil sources, and (2) changes in the balance of nutrients within the tissue resulting from the chloride additions.

Procedures

In 1973, two studies involving the addition of chloride to tobacco were conducted at the Tobacco Experimental Farm near Upper Marlboro, Md. Both experiments were conducted on a Monmouth fine sandy loam and were fertilized according to soil test recommendations. Both were planted with Md 609 variety, cultured, harvested and cured consistant with established procedures for Maryland air-cured tobacco.

A randomized complete block design with four replications was used for both studies. In an effort to simulate aerial drift of chloride from an operating cooling tower, sodium chloride was applied as spray mist on plots at rates equal to 0, 1.82, 3.64, 7.28 and 14.56 kg ha^{-1} wk^{-1} once a week for eight weeks. (Methods used for applying the spray have been previously described.) In an effort to examine the consequences of chloride buildup in the soil on tobacco, soil chloride was applied at rates equal to 0, 11, 22, 44, 88, 176 and 352 kg ha^{-1} prior to the transplanting of the tobacco plants. For the soil chloride study,

$CaCl_2$ was used as the source of chloride. A plot consisted of two rows 7.6 meters in length and one meter apart. Two border rows separated the plots receiving spray and single border rows separated the soil chloride plots.

During the stripping process, composite samples were collected from each plot, dried at 60°C, ground and analyzed for P, K, Ca, Mg, Na and Cl in the Soil Testing Laboratory and Tobacco Chemistry Laboratory. The balance of nutrients in the cured tobacco was determined by calculating the metabolic index (Ca + Ma + K + P / Na + Cl) for each treatment.

In order to gain information on the general nutrient balance and chloride status of tobacco grown throughout Southern Maryland, 81 samples of tobacco which had been collected from farms from the 1973 crop were analyzed in a similar manner as the samples from the chloride studies. It was of interest to compare the nutrient results from the chloride studies with tobacco grown in the state.

Results

Summaries of the nutrient data from both studies are listed in Table 1. In the salt spray study, there were no significant effects of treatments on the P, K, Ca or Mg contents in the tissue. However, there was a definite trend for an inverse relationship between K and Na contents. Significant increases in both Na and Cl contents were found. The increased Na and Cl levels combined to induce significant reductions in the metabolic index values with increased salt spray treatments.

In the soil chloride study, nonsignificant differences were found for P, K, Mg and Na contents with increased $Ca\ Cl_2$ treatments. A trend for lower K contents with increased Ca contents was evident. Significant

increases in both Ca and Cl contents were found. The increased Ca contents were not substantial enough to effectively cancel the increased Cl levels; therefore, significant reductions in the metabolic index resulted.

The metabolic index values generally corresponded to the total chloride applied, irrespective of source. There appears to have been a greater efficiency of chloride uptake from the aerial spray treatments which was expected due to the leachability of Cl in soils.

The nutrient survey data for tobacco throughout Southern Maryland is shown in Table 2. With only minor exceptions, the data means are very consistant with the means obtained from the zero chloride treatments (Table 1). Also note that there are low variations in the P, K, Ca, Mg and Na values. Chloride appears to be very variable which causes a wide variation in the metabolic index values. Possible sources of excess chloride on tobacco could be the result of chloride buildup in soils following heavy use of chloride containing soil fumigants for pest control or the misuse by farmers of fertilizers not registered for use on tobacco such as 10-10-10.

Summary

Studies involving the application of chloride to tobacco from both aerial spray and soil additions were conducted at the Tobacco Experimental Farm in 1973. Of primary interest were the uptake of chloride from both sources and the effects of chloride uptake on the balance of other nutrients in the tissue. Increased rates of sodium chloride spray up to 14.56 kg ha^{-1} wk^{-1} for eight weeks did not significantly affect the P, K, Ca, or Mg contents in cured tobacco. Calcium chloride additions up to 352 kg ha^{-1} did not significantly alter the P, K, Mg or

Na contents in cured tobacco. Significant increases in Na and Cl contents were found in the salt spray study and significant increases in Ca and Cl contents were observed in the soil chloride study. Significant reductions in metabolic index values were found in both studies with increased chloride treatments.

The nutrient data from the control plots in both studies compared very favorably with means for nutrient contents and metabolic index values obtained from the analysis of farmer samples from the 1973 crop.

Acknowledgement

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Table 1. Mineral analysis of composite samples of Maryland air-cured tobacco following chloride additions from aerial spray and soil chloride sources. 1973.

Salt Spray Study

Salt (NaCl) Treatment [a]	Accumulative Chloride	P	K	Ca	Mg	Na	Cl	Metabolic Index [e]
kg $ha^{-1}wk^{-1}$ [b]	kg ha^{-1} [b]	%	%	%	%	%	%	(1)
0	0	0.24	3.6	3.94	1.01	0.129	0.199	27.8
1.82	8.8	0.23	3.5	3.79	1.10	0.195	0.365	15.7
3.64	17.6	0.23	3.3	4.04	1.14	0.299	0.519	10.7
7.28	35.2	0.22	3.3	4.01	1.09	0.450	0.878	6.6
14.56	70.4	0.24	3.1	4.34	1.08	0.658	1.519	4.0
Mean ($\bar{x}$)		0.23	3.4	4.02	1.08	0.346	0.696	12.9
LSD (0.05)		NS [c]	NS	NS	NS	0.090	0.117	3.9
CV (%)		9.7	10.0	10.3	7.3	17.1	11.0	19.4

Soil Chloride Study

Chloride Applications [d]	P	K	Ca	Mg	Na	Cl	Metabolic Index
kg ha^{-1} [b]	%	%	%	%	%	%	(1)
0	0.24	4.4	3.65	0.92	0.118	0.194	30.1
11	0.27	4.5	3.40	0.86	0.117	0.333	21.1
22	0.26	4.4	3.75	0.97	0.112	0.529	14.8
44	0.26	4.4	3.40	0.88	0.114	0.809	9.9
88	0.24	4.4	3.71	0.89	0.113	1.513	5.8
176	0.26	4.1	3.97	0.90	0.104	2.455	3.0
352	0.26	3.9	4.36	1.06	0.120	4.726	2.0
Mean ($\bar{x}$)	0.25	4.3	3.75	0.93	0.115	1.580	12.4
LSD (0.05)	NS [c]	NS	0.62	NS	NS	0.305	3.9
CV (%)	6.9	8.2	11.1	11.2	12.8	13.0	20.9

a/ Applied as sodium chloride solution spray once per week for eight weeks.

b/ To convert to lbs A^{-1}, divide by 1.1.

c/ NS equals nonsignificant differences between means.

d/ Applied as $CaCl_2$ to soil prior to transplanting.

e/ Calculated as Ca + Mg + K + P / Na + Cl.

Table 2. Mean ($\bar{x}$), standard deviation ($S\bar{x}$) and coefficient of variation (%) for mineral analysis data for cured tobacco samples from 81 farms in Southern Maryland. 1973.

	P	K	Ca	Mg	Na	Cl	Metabolic Index (1)
	%	%	%	%	%	%	
Mean ($\bar{x}$)	0.21	4.51	3.48	1.18	0.139	0.269	29.9
Std. dev. ($S\bar{x}$)	0.03	0.72	0.72	0.21	0.011	0.279	13.4
CV (%)	12.3	15.9	20.7	18.2	8.1	103.8	44.7

Effects of Chloride on Maryland Tobacco

Charles L. Mulchi and Wilbur W. Newcomb
Department of Agronomy

Purpose and Objectives

In Maryland, the amount of chloride which may be contained in fertilizers used for tobacco is regulated to not exceed 0.5 percent plus 5.0 percent of the potassium content of the fertilizer. Excess chlorine has been shown to adversely affect the physical and chemical properties of cured tobacco. However, only a limited amount of research has been conducted involving the effects of chlorine on Maryland air-cured tobacco. Information was needed regarding the potential effects of chloride released from cooling towers operating on brackish water on the growth and quality of tobacco produced near the towers.

Procedures

During 1973 and 1974, experiments with chloride from aerial sprays and from soil applications were conducted with Maryland tobacco at the Tobacco Experimental Farm near Upper Marlboro, Md. All studies were conducted on a Monmouth fine sandy loam soil and were fertilized according to soil test recommendations. Also, all studies were planted with variety Md. 609, cultured, harvested and cured consistant with established practices for Maryland air-cured tobacco.

Two basic types of experiments were conducted in both 1973 and 1974 involving chloride: (1) salt (NaCl) spray on the plants throughout the growing season and, (2) calcium chloride ($CaCl_2$) applied to the soil prior to transplanting. The salt spray treatments in 1973 consisted of applying 0, 1.82, 3.64, 7.28 and 14.56 kg ha^{-1} wk^{-1} of sodium chloride once a week for eight weeks. (The method of applying the salt spray was

described in a previous Crops and Soils report involving salt sprays on soybeans). The soil chloride treatments in 1973 were the application of 0, 11, 22, 44, 88, 176 and 352 kg ha^{-1} of chloride. In 1974, the salt spray treatments were the application of 0, 5.6, 11.2, 16.8 and 22.4 kg ha^{-1} wk^{-1} of sodium chloride in five applications per week for eight weeks. The soil chloride treatments in 1974 were the application of 0, 22, 44, 66, 88, 176 and 352 kg ha^{-1} of chloride. In all studies, a plot consisted of two rows 7.6 meters in length and one meter apart. A randomized complete block design was used for all experiments with four and three replications in 1973 and 1974, respectively. Two border rows separated the salt spray plots and single border rows separated the soil chloride plots.

After curing, data was collected on tobacco yields (lbs. A^{-1}), average price ($ 100 lbs.$^{-1}$), value ($ A^{-1}) and quality index of the cured tobacco. Composite samples were obtained from the cured tobacco from each plot and analyzed for total nitrogen, total akaloids, and total chloride contents in the Tobacco Chemistry Laboratory.

Results

The results from the salt spray and soil chloride studies are summarized in Tables 1 and 2, respectively. In general, no significant effects were found in the salt spray studies other than significant increases in total chloride contents with increased rates of salt spray. However, in the soil chloride studies, significant reductions in average price and quality ratings were noted for treatments above 44 kg ha^{-1} (40 lbs. A^{-1}) of chloride which is consistant with reports published for other types of tobacco.

The primary causes for the lack of response in the salt spray studies are not known at this time. However, the elevated chloride levels in the leaves following spray treatments clearly suggest that chloride is rapidly entering the plant. In general, the levels of chloride in the tissue corresponded to the total levels of chloride applied, irrespective of whether it was sprayed on the leaves or applied to the soil prior to planting. There is evidence that some of the soil chloride may have leached from the rooting zone as a consequence of moderately wet conditions early in the 1974 growing season.

These results suggest that there is little physical evidence of reduced quality in tobacco receiving less than 44 kg ha^{-1} (40 lbs. A^{-1}) of chloride. However, further studies involving quality factors such as burning rates, filling capacities and moisture holding properties need be included before final conclusions can be drawn.

Summary

The effects of chloride from airial spray during the growing season and soil applications prior to planting on Maryland tobacco were investigated at the Tobacco Experimental Farm in 1973 and 1974. In the spray studies, no significant differences were found in treatments up to 22.4 kg ha^{-1} wk^{-1} (20 lbs. A^{-1}) as NaCl spray for eight weeks on yields, price, value, quality, total nitrogen or total alkaloid levels in composite samples of cured tobacco. Significant increases in tissue chloride levels with increased levels of salt spray were found.

In the soil chloride studies, significant reductions in both average price and quality ratings were found with chloride applications above 44 kg ha^{-1} (40 lbs. A^{-1}). No significant differences in value per acre, total nitrogen or total alkaloid contents were observed with treatments;

however, significant increases in tissue chloride levels were noted with increased rates of soil chloride.

Acknowledgement

Finiancial support for the research was provided by the Maryland Department of Natural Resources - Power Plant Siting Program and administered through the Water Resources Research Center. The authors wish to thank Dr. Jerry Pell; Project Director for the Chalk Point Cooling Tower Project, and Dr. R. L. Green, Coordinator of the Water Research Center, for their assistance with the project.

Table 1. Effect of salt spray treatments on yield, price, value, quality, total nitrogen, total alkaloids and chloride contents of cured Maryland Tobacco, 1973 & 1974.

Salt (NaCl) Treatments kg ha^{-1} wk^{-1} [b]	Accumulative Chloride kg ha^{-1} [b]	Yield lbs A^{-1}	Price $ 100 lbs^{-1}	Value $ A^{-1}	Quality Index (0-100) [c]	Total Nitrogen %	Total Alkaloids %	Total Chloride %
			1973					
0	0	1996	84.25	1683	82.4	3.05	2.87	0.198
1.82	8.8	2042	84.79	1732	83.5	2.98	2.81	0.365
3.64	17.6	2163	85.04	1842	84.5	2.94	3.06	0.519
7.28	35.2	2053	84.33	1733	81.8	2.75	2.64	0.878
14.56	70.4	2023	84.26	1706	82.0	3.08	2.86	1.519
Mean ($\bar{x}$)		2056	84.53	1739	82.8	2.96	2.84	0.696
LSD (0.05)		NS [d]	NS	NS	NS	NS	NS	0.117
CV (%)		7.8	0.8	8.3	5.3	11.1	7.6	11.0
			1974					
0	0	1772	88.46	1566	83.7	3.18	3.75	0.073
5.6	27.2	1725	88.22	1520	84.8	3.28	3.78	0.433
11.2	54.4	1647	87.98	1449	84.6	2.89	3.48	0.840
16.8	81.6	1685	88.65	1493	84.3	2.86	3.69	1.277
22.4	108.8	1733	87.27	1512	81.8	2.90	3.76	1.497
Mean ($\bar{x}$)		1712	88.12	1508	83.8	3.02	3.69	0.769
LSD (0.05)		NS [d]	NS	NS	NS	NS	NS	0.115
CV (%)		9.6	1.6	8.3	7.5	8.5	5.6	8.0

[a] Salt solutions were applied once per week in 1973 and five days per week in 1974 for a period of eight weeks.

[b] To convert to lbs A^{-1}, divide by 1.1.

[c] Based on relative comparisons between all 63 USDA Maryland Tobacco grades with C1F as the standard equalling 100.

[d] NS equals nonsignificant differences between means.

Table 2. Effects of soil chloride applications on yield, price, value, quality, total nitrogen, total alkaloids and chloride contents of cured Maryland Tobacco, 1973 & 1974.

Chloride [a] Application kg ha^{-1} [b]	Yield lbs A^{-1}	Price $ 100 lbs^{-1}	Value $ A^{-1}	Quality Index (0-100)	Total Nitrogen %	Total Alkaloids %	Total Chloride %
			1973				
0	1850	83.68	1548	78.3	3.08	2.36	0.194
11	1871	83.04	1553	77.5	2.29	2.21	0.333
22	1918	84.04	1612	81.5	2.97	2.19	0.530
44	1784	83.76	1495	80.5	2.95	2.04	0.810
88	1963	81.61	1603	66.9	2.89	2.03	1.513
176	1826	81.66	1492	63.5	2.88	1.89	2.957
352	2031	78.87	1602	47.9	3.32	2.34	4.726
Mean ($\bar{x}$)	1892	82.38	1557	70.9	3.05	2.15	1.580
LSD (0.05)	NS [c]	1.33	NS	7.0	NS	NS	0.306
CV (%)	9.8	1.1	9.7	6.8	13.3	17.3	13.0
			1974				
0	1500	89.28	1339	88.9	2.81	3.16	0.035
22	1576	89.37	1408	87.5	2.69	3.17	0.095
44	1657	87.58	1452	78.7	2.80	3.22	0.304
66	1566	88.37	1355	80.8	2.56	3.14	0.529
88	1599	88.28	1411	78.6	2.78	3.08	0.491
176	1373	85.64	1178	63.2	2.74	2.93	2.498
352	1757	84.30	1483	50.7	2.85	3.23	3.307
Mean ($\bar{x}$)	1575	87.52	1375	75.5	2.75	3.13	1.037
LSD (0.05)	201	1.92	NS	9.3	NS	NS	0.780
CV (%)	7.2	1.2	7.6	6.9	6.1	9.9	42.4

a/ Applied as $CaCl_2$ to soil prior to transplanting.
b/ To convert to lbs. A^{-1}, divide by 1.1.
c/ NS equal nonsignificant difference between means.

Salt Spray Effects on Yield and Vegetative Nutrient Contents in Soybeans

Charles L. Mulchi and J. A. Armbruster
Department of Agronomy

Purpose and Objectives

Information on the potential detrimental effects of salts to soybeans was needed to evaluate possible damage from salt spray drift from cooling towers operating on brackish water. In 1973, studies involving the application of increasing amounts of salt spray mist to soybeans were initiated. Of primary interest in these studies were: (1) To determine the rates of salt drift which would cause yield reductions, and (2) to examine the effects of foliar application of salts and the balance of nutrient ions in the vegetation.

Procedures

Experiments in 1973 and 1974 were conducted at the Tobacco Experimental Farm near Upper Marlboro, Maryland on a Monmouth fine sandy loam soil. Each plot contained four rows 7.6 meters in length and one meter apart. A randomized complete block design with five treatments and four replications was used in both experiments. The two center rows received the spray treatments.

The 1973 treatments were the application of 0, 1.82, 3.64, 7.28 and 14.56 kg ha^{-1} wk^{-1} of NaCl for eight weeks. In 1974, the treatments were the application of 0, 5.6, 11.2, 16.8 and 22.4 kg ha^{-1} wk^{-1} of NaCl for eight weeks. The weekly treatments were applied as a single spray treatment in 1973 and daily treatments for five days per week in 1974. The materials were NaCl solutions which were applied early in the mornings during periods of low winds. The sprayer was equipped with two nozzles spaced one meter apart and was adjusted to approxi-

mately 0.5 meters above the tops of the plants at each spraying. A pressure of 2.81 kg cm^{-2} (40 lbs. in^{-2}) was maintained for all treatments. The salt mist droplets were examined with salt sensitive paper and found to average 100 micrometers in diameter, a size range similar to droplets which may escape from operating cooling towers.

Vegetative samples were collected at the end of the spray treatments in 1973 and following the third, fifth and eighth week of spray treatments in 1974. The entire leaf canopy was removed from approximately ten plants per plot, washed in distilled water, dried at 60°C, ground and stored in glass containers. Analysis for P, K, Ca, Mg, Na and Cl contents were conducted in the Soil Testing Laboratories and Tobacco Chemistry Laboratory.

Yields were determined in the fall by harvesting grain from 6.1 meters of the two center rows of each plot. Grain yields were corrected to 12.5% moisture.

The metabolic index is a mathematical expression of the collective invluence of sodium and chloride ions on the overall balance of other major nutrient ions in the tissue. It is calculated by dividing the Ca + Mg + K + P by the Na + Cl contents. In general, healthier plants have a higher metabolic index.

Results

The data shown in Tables 1 and 2 summarize the effects of spray treatments on the nutrient ions in the soybean tissue. The effects on Ca, Mg and K levels appeared to have been nonsignificant; however, there appeared to have been an increase in P contents with increased levels of salt spray in the fifth and eighth week samples in 1974.

The major effects of salt spray treatments were noted in the Na and Cl data which showed highly significant increases with increased levels of salt spray in both studies. Also, the chloride levels increased much greater than sodium levels. The combined increases in Na and Cl induced significant decreases in the metabolic index values in both studies. The metabolic index values for the check plots in both studies were quite similar and were substantailly larger than those from plots receiving salt spray. Although the treatments were not the same for the two studies, the decrease in the index values were generally comparable for equivalent amounts of salt applied. The metabolic index appears to be a valid tool for assessing deposition of salt spray from actual operating towers on soybeans.

The effects of salt spray on soybean yields are shown in Table 3. These results suggest that salt drift in amounts larger than approximately 5.6 kg ha^{-1} wk^{-1} (5.0 lbs. A^{-1} wk^{-1}) may cause yield reductions in soybeans. Also shown in Table 3 are the grain moisture contents at harvest. No apparent effects of salts on the moisture contents of the beans at harvest were found.

Summary

Studies were initiated in 1973 to investigate the effects of salt spray on soybeans. Results from studies conducted in 1973 and 1974 show salt spray to have generally nonsignificant effects on the Ca, Mg, K or P contents in vegetative tissue. Significant increases in Na and Cl contents were noted with Cl being much more abundantly absorbed than Na. Soybean plants growing in the absence of salt spray had metabolic index values of around 30. The metabolic index values rapidly declined with additions of salt spray which supports the concept of metabolic index

being a useful tool for assessing the deposition of salts from operating cooling towers on soybeans.

Yields of soybeans were depressed in treatments receiving salt spray in excess of 5.6 kg ha^{-1} wk^{-1}. Grain moisture levels were not significantly effected by salt spray treatments.

Acknowledgements

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Table 1. Nutrient Contents and Metabolic Index Values of Soybean Leaves Following Salt Spray Applications for Eight Weeks - 1973.

Salt (NaCl) Treatments	Nutrients [a]						Metabolic Index (I) [b]
kg ha^{-1} wk^{-1}	Ca	Mg	K	P	Na	Cl	
0	1.30	0.50	1.90	0.33	0.065	0.069	32.1
1.82	1.05	0.37	1.70	0.26	0.098	0.260	9.9
3.64	1.49	0.56	2.10	0.36	0.114	0.503	7.2
7.28	1.35	0.53	2.00	0.34	0.142	0.689	5.1
14.56	1.60	0.67	2.20	0.42	0.211	1.310	3.2
Mean	1.36	0.58	2.00	0.34	0.122	0.567	11.6
LSD (0.05)	NS [c]	0.18	NS	NS	0.091	0.114	9.5
CV (%)	19.4	22.5	19.1	20.4	48.8	13.1	53.4

[a] Expressed as percent of dry weight. Average of four replication of plant canopy samples taken after last spray treatment.

[b] Metabolic Index = Ca + Mg + K + P / Na + Cl

[c] NS indicates nonsignificant difference between values.

Table 2. Nutrient Contents and Metabolic Index Values of Soybean Leaves at Various Intervals During the Eight Weeks of Salt Spray Treatments - 1974.

Salt (NaCl) Treatments kg ha^{-1} wk^{-1}	Sample Period (wks) a/	Nutrients (%) Ca	Mg	K	P	Cl	Na	Metabolic Index (1) b/
0	3	1.73	0.61	2.7	0.36	0.06	0.13	29.9
	5	1.77	0.57	2.3	0.36	0.06	0.13	27.0
	8	1.73	0.52	1.9	0.33	0.05	0.11	27.6
5.6	3	1.69	0.61	2.6	0.37	0.47	0.30	7.1
	5	1.77	0.58	2.3	0.39	0.45	0.25	7.5
	8	1.75	0.51	1.8	0.32	0.40	0.14	8.5
11.2	3	1.60	0.58	2.5	0.38	0.95	0.53	3.5
	5	1.70	0.56	2.3	0.41	1.06	0.40	3.5
	8	1.67	0.51	1.8	0.32	0.75	0.21	4.9
16.8	3	1.75	0.60	2.5	0.38	1.07	0.59	3.2
	5	1.66	0.60	2.2	0.43	1.31	0.61	2.6
	8	1.55	0.52	1.9	0.35	0.90	0.27	3.8
22.4	3	1.67	0.60	2.5	0.39	1.39	0.75	2.5
	5	1.61	0.59	2.3	0.42	1.38	0.61	2.5
	8	1.54	0.54	2.0	0.38	0.98	0.27	3.6
Mean	3	1.69	0.60	2.6	0.37	0.79	0.46	9.2
	5	1.71	0.58	2.3	0.40	0.85	0.40	8.6
	8	1.64	0.52	1.9	0.34	0.62	0.20	9.7
LSD (0.05)	3	NS c/	NS	NS	NS	0.19	0.10	3.3
	5	NS	NS	NS	0.02	0.19	0.08	2.3
	8	NS	NS	NS	0.02	0.19	0.05	3.1
CV (%)	3	6.0	5.3	6.9	4.9	15.6	13.6	23.1
	5	8.7	5.6	4.4	3.7	14.2	13.0	17.6
	8	6.9	4.9	7.1	4.5	20.0	17.3	20.8

a/ The entire plant canopy was samples, four replications.

b/ Determined by dividing the Ca + Mg + K + P by the Cl + Na.

c/ NS indicates nonsignificant differences between values.

Table 3. Yields and Moisture Contents of Soybeans Subject to Salt Spray Applications for Eight Weeks.

Salt (NaCl) Treatment kg ha^{-1} wk^{-1} a/	Yield kg ha^{-1}	Yield Bu A^{-1}	Moisture %
	1973		
0	3192	47.5	13.2
1.82	3319	49.4	13.4
3.64	3192	47.5	14.1
7.28	2768	41.2	13.3
14.56	2621	39.0	13.6
Mean	3010	44.8	13.5
LSD (0.05)	262	3.9	NS
CV (%)	5.8	5.8	3.9
	1974		
0	2650	39.4	13.5
5.6	2728	40.6	13.9
11.2	2386	35.5	13.7
16.8	2072	30.8	13.5
22.4	1430	21.3	13.4
Mean	2253	33.5	13.6
LSD (0.05)	322	4.8	0.3
CV (%)	22.2	22.2	2.6

a/ To convert to lbs A^{-1} wk^{-1}, divide by 1.1.

Influence of Salt Spray on Yields and Metabolic Index Values for Corn

Charles L. Mulchi and J. A. Armbruster
Department of Agronomy

Purpose and Objectives

Corn is a major cash crop in the area surrounding the Chalk Point Cooling Towers located on the Patuxent River. Information on the potential damaging effects of salt drift from operating cooling tower is needed to compare with data being obtained from a monitoring program being carried out in the Chalk Point area. Of particular interest are: (1) the effects of salt drift on corn yields and (2) the effects of ions from salt spray on the balance of other nutrient ions in the plant leaves.

Procedures

Studies were initiated in 1973 at the Tobacco Experimental Farm near Upper Marlboro, Maryland where increasing amounts of salt spray were applied to corn plots. The plots were located on Monmouth fine sandy loam soil and consist of four rows 7.6 meters in length and one meter apart. A randomized complete block design was employed with four replications in the 1973 and 1974 studies.

The spray treatments were initiated within a week after plant emergence and continued for eight weeks. In 1973, the treatments were the application of 0, 1.82, 3.64, 7.28 or 14.56 kg ha^{-1} wk^{-1} of NaCl applied once a week as solution spray. In 1974, the treatments were the application of 0, 5.6, 11.2, 16.8 or 22.4 kg ha^{-1} wk^{-1} of NaCl solution applied five days per week. In addition, applications of 11.2 and 22.4 kg ha^{-1} wk^{-1} were applied in 1974 to plots for ten days during tasseling only. (A description of the methods of applying the salt spray is included in the preceeding report.)

Vegetative samples were taken following the last spray treatment in 1973 from the point of ear attachment. In 1974, vegetative samples were collected at three periods - i.e. on the third week after initiating treatments; following the fifth week of spraying, and after the last spray treatment which coincided with the end of the 10 days of spraying during tasseling. The samples were washed with distilled water, dried at 60°C, ground and stored in glass containers. The samples were analyzed for Ca, Mg, K, P, Na and Cl in the Soil Testing Laboratory and Tobacco Chemistry Laboratory. In the fall, yield estimates were made by harvesting 6.1 meters from each of the two center rows. Grain moisture levels were determined and yields were adjusted to 12.5% moisture.

Results

There were significant reductions in the Ca and K contents with increased salt spray rates (Tables 1 & 2). No apparent affects on either Mg or P levels with treatments were observed. However, there were significant increases in Na and Cl levels with treatments. The metabolic index (calculated by adding the Ca, Mg, K and P level and dividing by the sum of Na + Cl) declined significantly with increased rates of salt spray. Also, the index values for the control plots were quite similar for the two studies. The overall response of the index values for both studies with salt treatments suggest that it may be an effective tool for assessing salt deposition on corn growing in areas under the influence of operating cooling towers using saltwater.

The Na showed a greater response than the Cl in the 1974 study which was opposite of the patterns noted in the 1973 study. This could be related to slower rates which the salts were applied in 1974 than in 1973. Also, the generally drier growing season in 1974 may have

influenced the Na and Cl uptake rates.

There were significant yield reductions with increased rates of salt application (Table 3). These results suggest that corn plants may not tolerate more than 5.6 kg ha^{-1} wk^{-1} salt deposition without serious effects on yields. The 1973 study suggest that less than 5.6 kg ha^{-1} wk^{-1} may lower yields. The response to spray treatments during tasseling suggest that the total amount of salt applied is perhaps more important than when the salt is applied since tasseling is considered a critical period in corn production.

The salt treatments caused no changes in the grain moisture levels at harvest.

Summary

Studies were conducted in 1973 and 1974 to investigate the affects of salt spray on the yields and nutrient status of corn. Increasing amounts of salt spray caused reductions in both Ca and K contents in plant leaves but no effects on either Mg or P contents. Tissue Na and Cl contents were significantly increased with increasing amounts of salt spray. Significant reductions in the metabolic index values were observed with increased levels of salt spray.

Significant yield reductions were found at salt spray rates exceeding 5.6 kg ha^{-1} wk^{-1} but no affects on grain moisture levels were noted.

Acknowledgements

The authors wish to express their appreciation to the Maryland Department of Natural Resources - Power Plant Siting Program for their financial support of the project.

Table 1. Effects of Salt Spray Applications on the Nutrient Contents and Metabolic Index Values in Corn Leaves - 1973. [a]

Salt (NaCl) Treatments [c] kg ha^{-1} wk^{-1}	Nutrients [b] Ca	Mg	K	P	Cl	Na	Metabolic Index [d] (I)
0	0.43	0.28	3.18	0.32	0.312	0.061	11.7
1.82	0.44	0.29	3.20	0.34	0.364	0.095	9.3
3.64	0.36	0.24	2.83	0.30	0.471	0.110	6.6
7.28	0.30	0.18	1.90	0.22	0.804	0.211	2.6
14.56	0.36	0.22	2.23	0.29	1.030	0.313	2.2
Mean	0.38	0.24	2.66	0.29	0.596	0.158	6.5
LSD (.05)	0.10	NS[e]	0.89	NS	0.094	0.117	2.4
CV (%)	16.7	21.6	21.7	21.1	10.2	48.4	23.8

a/ Sampled from point of ear attachment following last spray treatment.

b/ Average of four replications. Expressed as percent of dry weight. To convert to ppm, multiply by 10^4.

c/ Applied as concentrated sodium chloride solution spray on weekly basis for eight weeks. To convert to lbs. A^{-1}, divide by 1.1.

d/ Determined by dividing the Ca + Mg + K + P by Cl + Na.

e/ NS indicates nonsignificant difference between values.

Table 2. Effects of Salt Spray Treatments[a] on Nutrient Contents and Metabolic Index Values for Corn - 1974.

Salt (NaCl) Treatments kg ha^{-1} wk^{-1} [b]	Sample Period (wks)	Nutrients Ca	Mg	K	P	Cl	Na	Metabolic Index (1)
		----------%----------						
0	3	0.36	0.28	3.2	0.25	0.22	0.14	11.88
	5	0.58	0.32	2.4	0.24	0.14	0.13	13.52
	8	0.61	0.34	2.1	0.29	0.17	0.18	9.68
5.6	3	0.35	0.28	2.9	0.27	0.30	0.30	6.34
	5	0.52	0.33	2.1	0.23	0.27	0.41	4.73
	8	0.56	0.33	1.6	0.27	0.23	0.58	3.50
11.2	3	0.38	0.28	2.8	0.26	0.61	0.56	3.33
	5	0.52	0.33	1.5	0.22	0.40	0.74	2.38
	8	0.57	0.36	1.2	0.29	0.42	0.96	1.74
16.8	3	0.35	0.29	2.7	0.27	0.94	0.63	2.34
	5	0.54	0.33	1.3	0.23	0.65	0.80	1.84
	8	0.53	0.36	1.0	0.29	0.62	1.06	1.28
22.4	3	0.35	0.28	2.4	0.27	0.90	0.90	1.92
	5	0.50	0.37	1.0	0.24	0.85	1.24	1.04
	8	0.52	0.35	0.9	0.29	0.63	1.21	1.13
11.2 T [c]	8	0.59	0.34	1.8	0.28	0.32	0.46	4.15
22.4 T [c]	8	0.53	0.34	1.5	0.28	0.34	0.62	2.85
Mean	3	0.36	0.28	2.8	0.26	0.59	0.51	5.16
	5	0.53	0.33	1.7	0.23	0.46	0.66	4.70
	8	0.56	0.34	1.4	0.28	0.39	0.72	3.47
LSD (0.05)	3	NS	NS	0.3	NS	0.22	0.18	2.09
	5	NS	NS	0.4	NS	0.19	0.28	1.67
	8	0.05	NS	0.1	NS	0.09	0.13	0.95
CV (%)	3	10.8	8.4	7.7	5.1	24.5	22.5	26.3
	5	7.2	8.3	13.3	5.0	27.4	27.5	23.1
	8	6.3	5.3	6.6	5.8	15.3	11.8	18.3

[a] Applied five days per week for eight weeks.

[b] To convert to lbs. A^{-1} wk^{-1}, divide by 1.1.

[c] Applied for 10 days during tasseling.

Table 3. Summary of 1973 and 1974 Studies Regarding Salt Spray Effects on Corn Yields and Grain Moisture Contents.

Salt (NaCl) Treatments [a] kg ha^{-1} wk^{-1}	Yields kg ha^{-1}	Yields Bu A^{-1}	Grain Moisture %
	1973		
0	8590	137	20.9
1.82	7712	123	20.8
3.64	7649	122	20.9
7.28	6395	102	21.2
14.56	5267	84	20.8
Mean ($\bar{x}$)	7148	114	20.9
LSD (.05)	1505	24	NS
CV (%)	13.8	13.8	3.5
	1974		
0	6619	106	29.2
5.6	5938	95	29.2
11.2	5441	87	28.0
16.8	4558	73	28.4
22.4	3992	64	28.5
11.2 T [b]	6363	101	28.9
22.4 T [b]	5331	85	28.7
Mean ($\bar{x}$)	5463	87	28.7
LSD (.05)	726	12	NS
CV (%)	17.9	17.9	4.1

[a] To convert to lbs A^{-1} wk^{-1}, divide by 1.1. Treatments applied for eight weeks.

[b] Treatments applied for 10 days during tasseling.

Evaluating Quality in Maryland Air-Cured Tobacco

Charles L. Mulchi
Department of Agronomy

Purpose and Objectives

The term "quality", when used in reference to cured tobacco, has traditionally been very subjective. Definitions of quality have varied greatly among individuals associated with the tobacco industry.

For research purposes, the average prices paid for the various grades of tobacco on the open market have served as a general index of the quality of the tobacco. The average prices paid for Maryland tobacco have undergone rapid increases over the past ten years. For average price to continue to be an effective index of quality, the respective grades should maintain their relative order and magnitude during periods of rapid change.

This study was initiated to review the status of average prices as an index of tobacco quality and, if necessary, to develop an alternative system not related to average price system.

Procedures

In 1968, the Tobacco Grading Service of USDA revised the grading system used for air-cured Maryland tobacco and established the 63 grades in current use. Using market information published by the USDA Agricultural Marketing Service, Tobacco Division (1,2,3,4), statistics on prices paid for grades of Maryland tobacco for the period 1968-1973 were reviewed. In order to place the market averages for the 63 grades on the same basis for comparison, the grade receiving the highest average market price each year (CIF) was selected as the standard. All grades were compared to CIF by dividing their average prices by that

for CIF then multiplying by 100. The relative price for each grade is an expression of its relative percentage of the maximum average price for the particular year of interest. The relative prices for the various grades were grouped and averaged according to the five general categories of grades--i.e., C - thin crop, B - heavy crop, X - seconds, T - tips, and N - nondescript.

In an effort to develop an alternative quality evaluation system not related to market averages which would not be subject to changes from year to year, representatives from industry, USDA Tobacco Grading Service, and the University of Maryland tobacco research staff were asked to rate each of the 63 USDA grades for Maryland tobacco in terms of their quality or industrial usability. The ratings were based on values from 1 to 100 with the grade having the highest quality being 100. The responses were averaged thus forming a general numerical index of quality which could be used in addition to average prices for quality evaluations.

Results

The results in Figure 1 summarize the information calculated for relative prices for the five grade groups and the average market prices for Maryland tobacco for the period 1968-1973. The market average price increased on a somewhat linear basis approximately $20.00 per hundred pounds over the 1968-1973 period. Had the average prices for all grades increased in roughly proportional manner throughout this period, there would have been only small variation from the relative status as shown for 1968. This was clearly not the case as evidenced by the increases in all grade groups relative to CIF grade. These results can be interpreted as showing that tobacco with traditionally lesser quality experienced

more rapid increases in average price than CIF grade which is recognized as having the highest or most desirable quality characteristics. In addition, the top quality "C" group gained 11 percent on CIF, the intermediate quality "X" and "B" groups gained 15 and 16 percent, respectively, and the lower quality "T" and "N" groups gained 17 and 18 percent, respectively, over the six year period. The overall average relative price increased from 76 percent of CIF in 1968 to 91 percent by 1973. These trends suggest that a uniprice system for all grades may be approaching for Maryland tobacco, irrespective of "quality" characteristics.

The results in Table 1 summarize the ratings received from the various industry, government, and university representatives. A larger participation by industry representatives was desired since the true quality of cured tobacco would ultimately be determined by desirability of leaf characteristics for inclusion into blends of tobaccos during the manufacturing of tobacco products. The industry responses which were received represented major domestic and foreign interest.

As shown in Table 2, the Tobacco Grading Service representatives averaged the highest and the industry ratings the lowest. The ratings from the university research staff were intermediate compared with the others and appeared rather similar. The ratings from the Tobacco Grading Service representative were very similar to the 1968 relative price averages.

It is of interest that all those responding were consistent in their rankings of the highest quality grades and differences between rankings appeared at the lower quality grades. The main failure with using the average price system was apparent where there were substantial amounts

of lower quality tobacco in the variety or research plots. This alternative quality index system should be of value for assessing varieties, breeding lines, and effects of treatments where tobacco quality appears to have been impaired. The differences in quality will be magnified using the alternative system. The alternative system and average price system in current use should complement each other.

Summary

The concept of using the average market prices for grades of Maryland air-cured tobacco as a quality index was reviewed and found to exhibit a very narrow range. Faster rates of increases in average prices were found among the groups of tobacco grades which traditionally have been considered as possessing lesser quality compared to grade CIF. Also, the general increase in mean relative price for the 1968-1973 crops suggests that a uniprice market for all grades may be approaching for Maryland tobacco.

An alternative quality index based on estimates by representatives from industry, government, and the University of Maryland was developed and presented. The system features a wider range of values for grades than exist with the average price system. The alternative system is based on quality or industrial usability estimates from 1 to 100 for each of the 63 grades in current use. Excellent agreement was found among the higher quality grades between individual and industry estimates with major differences occuring at the lower quality grades. The alternative system would complement the average price system and magnify differences among varieties, treatments, etc. having substantial quantities of poor quality tobacco.

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Table 1. Summary of Maryland air-cured tobacco quality estimates from industry, government and University of Maryland representatives. (Estimates based on quality ratings from 1 to 100).

USDA Grade	Quality Index	USDA Grade	Quality Index	USDA Grade	Quality Index	USDA Grade	Quality Index
C1L	95	B1F	93	T1F	76	X1L	82
C2L	88	B2F	85	T2F	68	X2L	72
C3L	81	B3F	77	T3F	61	X3L	60
C2V	56	B2V	50	T2V	40	X2V	46
C3V	49	B3V	44	T3V	35	X3V	40
C1F	100	B1R	72	T1R	58	X1F	89
C2F	94	B2R	66	T2R	53	X2F	81
C3F	88	B3R	56	T3R	45	X3F	69
C2K	53	B2K	50	T2K	42	X2K	44
C3K	46	B3K	42	T3K	34	X3K	37
C2R	76	B2D	56	T2D	46	X2R	66
C3R	66	B3D	49	T3D	38	X3R	56
C2G	32	B2G	26	T2G	22	X2G	25
C3G	25	B3G	21	T3G	16	X3G	20
C2D	64						
C3D	57	N1L	30	N1R	20	N1F	28
				N1G	7	N2	5

Table 2. Mean quality index ratings for grade groups of Maryland air-cured tobacco for individuals and industries participating in the survey.

Grade Group	Individuals 1/			Industries 1/				Quality Index
	A	B	C	A	B	C	D	
C	82	67	74	57	63	62	63	67
B	78	56	58	49	49	54	49	56
T	76	48	48	35	30	50	30	46
X	79	58	65	44	49	48	49	56
N	30	28	27	10	9	12	9	18
Mean ($\bar{x}$)	76	56	60	44	45	51	45	54

1/ A = USDA Tobacco Grading Service, B and C are University of Maryland research and extension staff, respectively.

2/ A, B and C represents major U.S. Tobacco companies, D represents the international division of company B.

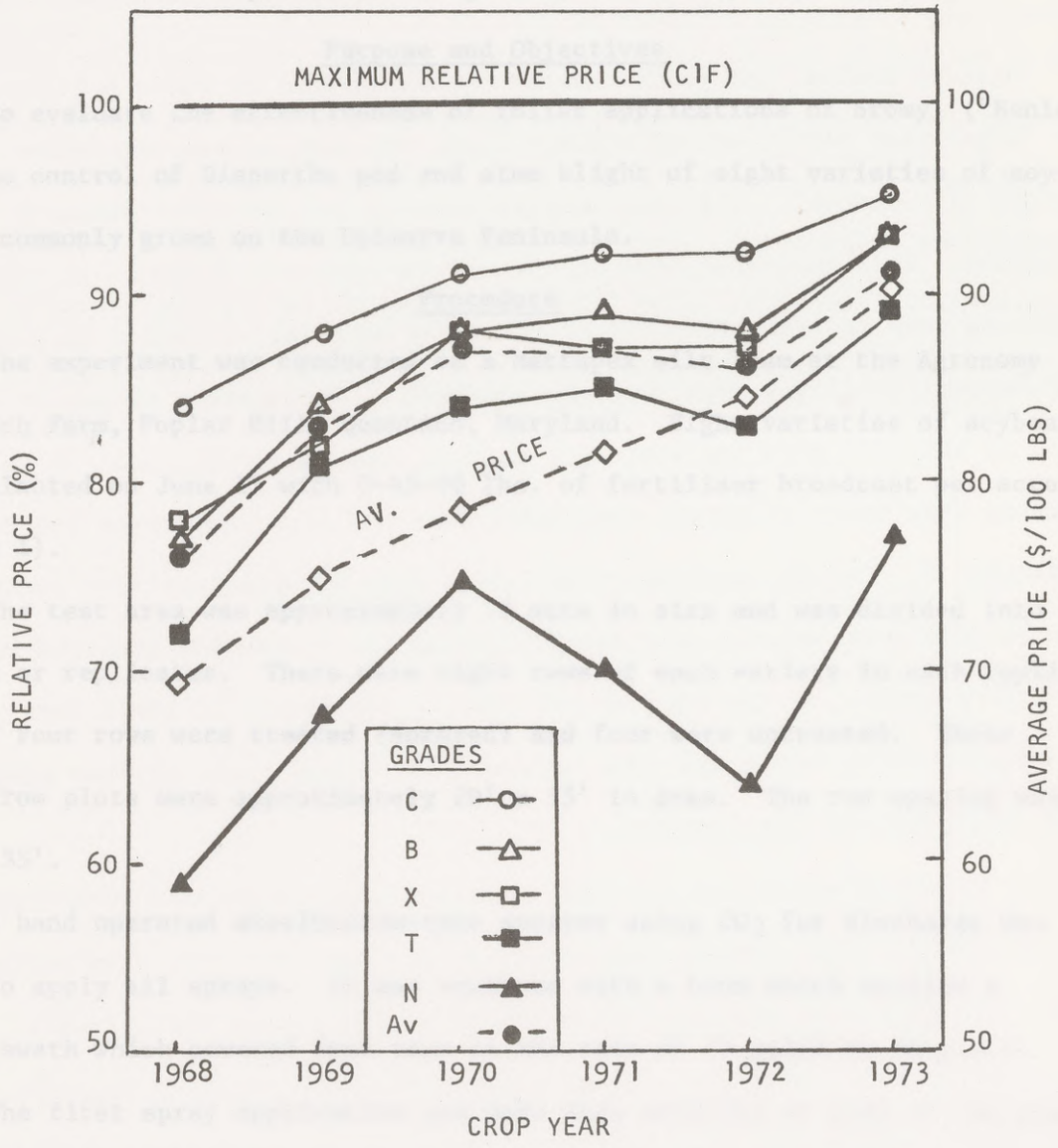
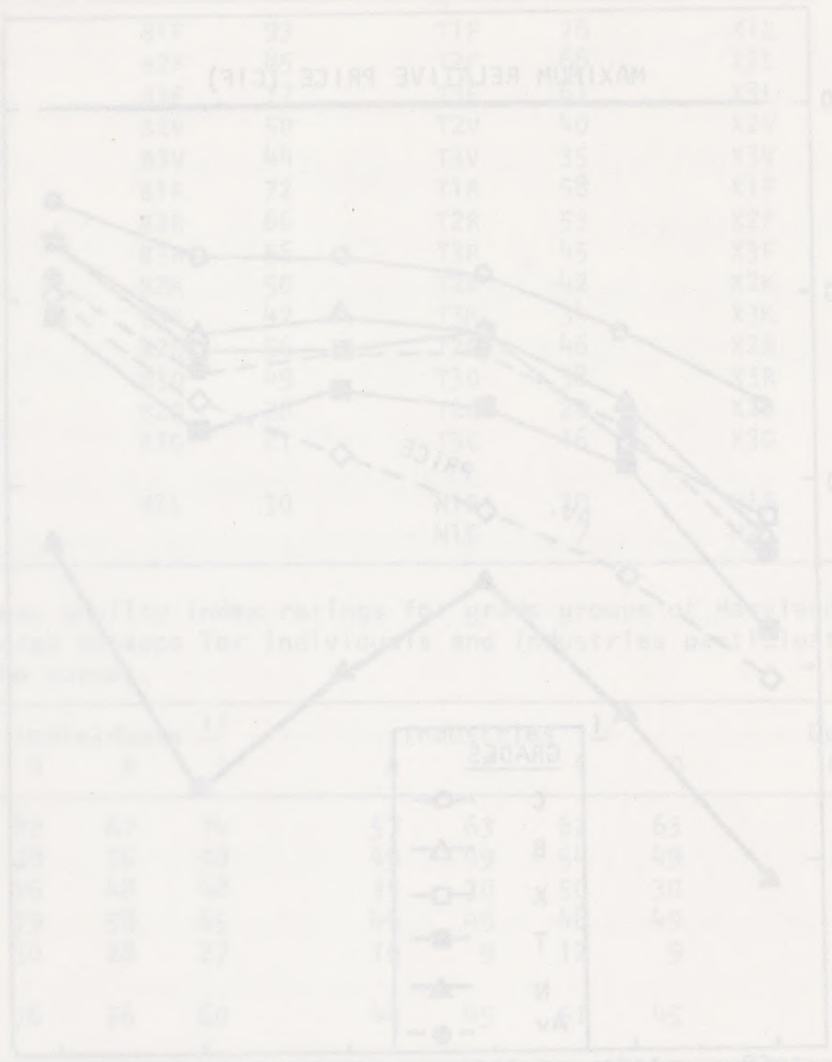


FIGURE 1. Changes in relative prices for grade groups and overall market price averages for Maryland tobacco from 1968-1973 crop years.



Spraying Soybeans with Benomyl ("Benlate") for Disease Control - 1974

F. R. Mulford and J. G. Kantzes
Departments of Agronomy and Botany

Purpose and Objectives

To evaluate the effectiveness of foliar applications of bromyl ("Benlate") for the control of Diaporthe pod and stem blight of eight varieties of soybeans commonly grown on the Delmarva Peninsula.

Procedure

The experiment was conducted on a Mattapex silt loam at the Agronomy Research Farm, Poplar Hill, Quantico, Maryland. Eight varieties of soybeans were planted on June 13 with 0-45-90 lbs. of fertilizer broadcast per acre (Table 1).

The test area was approximately .8 acre in size and was divided into 4 blocks or replicates. There were eight rows of each variety in each replicate. Four rows were treated (sprayed) and four were untreated. These eight-row plots were approximately 20' x 35' in area. The row spacing was 30" x 35'.

A hand operated wheelbarrow-type sprayer using CO_2 for discharge was used to apply all sprays. It was equipped with a boom which applied a spray swath which covered four rows at the rate of 15 gal/A at 30 p.s.i.

The first spray application was made when majority of pods on the plant ranged from 1/4 to 1 inch in length. The first spray application was made on August 12. Varieties sprayed at this time were: Wye, Cutler, Williams, and Kent. On August 19, the varieties Columbus and Delmar were sprayed. On September 5, all varieties were sprayed. At this time, this was the first application for the varieties Essex and York and the second application for all of the other varieties.

Results

Pod and stem blight (*Diaporthe phaseolorum* var *sojae*) was present in the plots but degree of infection was limited by reduced rainfall during podding. The growth of the late maturing varieties (Essex, York, and Delmar) was stopped by a freeze on October 3.

Disease control and yield results are summarized in Table 1. There was longer leaf retention and lighter stems and pods of some varieties sprayed with benomyl. This was readily apparent in the early maturing varieties. This indicated some control of pod and stem blight. In general, there was some increase in yield of the early maturing varieties unsprayed with benomyl (Williams, Wye, Cutler, and Kent). There was a reduction in yield of the late maturing varieties sprayed with this fungicide. It should be noted that these varieties were still immature when the freeze occurred on October 3. One may speculate that those late maturing varities sprayed with benomyl were injured more severly during the freeze and thus the reduction in yield. At the time of the freeze, the plants of these late maturing varieties which had been sprayed with benomyl were greener than those which had not been sprayed.

It should be noted that certain varieties have resistance to pod and stem blight and that disease resistance, in general, may vary from variety to variety with other diseases which may be controlled by the systemic fungicide benomyl. Therefore, it is anticipated that varietal response to benomyl sprays will vary with different varieties and additional studies will be required to find the proper role of benomyl sprays for disease control of soybeans in the Delmarva Area.

Summary

Spraying eight varieties of soybeans with benomyl was conducted to determine its effectiveness for the control of Diaporthe pod and stem blight. There was longer leaf retention and lighter stems and pods in the early maturing varieties. This indicated some control of pod and stem blight. Growth of the latter maturing varieties was stopped by a freeze on October 3. This caused a reduction in yield of these varieties because they were still immature when the freeze occurred. Since it is anticipated that varietal response to benomyl sprays will vary, additional studies will be required to find the proper role of this fungicide for disease control of soybeans.

Table 1. Effect of benomyl ("Benlate") sprays on yield of eight soybean Agronomy Research Farm, Poplar Hill, Quantico, Maryland. 1974.

Variety 1/	Yield (Bu/Acre) Sprayed	Unsprayed	Percent Increase
Williams*	43.2 2/	42.5	+ 1.6
Wye*	47.6	46.8	+ 1.7
Cutler*	37.6	34.7	+ 8.4
Kent*	37.2	34.7	+ 7.2
Columbus**	38.5	40.5	- 5.2
Delmar**	34.5	35.2	- 2.0
Essex***	37.4	41.9	-12.0
York***	35.9	39.4	- 9.7

* Two applications of benomyl @ 1/2 lb/A applied on August 12 and September 5.

** Two applications of benomyl @ 1/2 lb/A applied on August 19 and September 5.

*** One application of benomyl @ 1/2 lb/A applied on September 5.

1/ Planted on June 13 in plots 20' x 35' with eight rows per replicate (4 sprayed - 4 unsprayed).

2/ Mean yield from four 5' x 16' harvested areas. Beans harvested on November 15. Vine-killing freeze on October 3.

Control of Wheat Diseases with Foliar Fungicides - 1974

F. R. Mulford and J. G. Kantzes
Departments of Agronomy and Botany

Purpose and Objectives

To evaluate the effectiveness of various foliar fungicidal sprays on disease control and yield of wheat variety Blueboy.

Procedure

The experiment was conducted on a Mattapex silt loam at the Agronomy Research Farm, Poplar Hill, Quantico, Maryland. Blueboy variety was planted on October 23, 1973 with a planter application of 15-30-60 lbs of fertilizer per acre. Topdressing with 60-32-32 lbs of fertilizer was done on March 7, 1974.

Test area was approximately .7 acre in size. This area was divided into 4 blocks or replicates. There were 12 treatment plots in each block. The size of each treatment plot was 12' x 20'. All plots were randomized in each of the 4 replicates.

A hand operated wheelbarrow-type sprayer using CO_2 for discharge was used to apply all sprays. It was equipped with a boom which applied a spray swath width of 12' at the rate of 22.5 gal/A at 38 p.s.i.

The first spray application was applied on April 8. The wheat was about 14" in height. Several plots received a second application on April 23. At this time the wheat was in the early head stage.

Results

There was heavy infection of powdery mildew (Erysiphe graminis) throughout the test area. Mildew was well established on the lower leaves when the first spray application was applied. Septoria glume blotch was also present in the plot area at head stage but it was not very severe.

Disease control and yield results are summarized in Table 1 and 2. The treated plots yielded higher than the untreated plots. Increase in yield was greater when two fungicidal applications were applied. As indicated in Table 2, a number of the treatments exhibited a degree of control of powdery mildew.

The results obtained in this preliminary study will require additional investigation. Such studies are planned to further explore the feasibility of controlling certain disease of small grains with fungicidal sprays in the Maryland area.

Summary

Various foliar fungicidal sprays were conducted on Blueboy wheat to evaluate their effectiveness on disease control and yield. Disease control and yield were better when two fungicidal applications were applied. Several of the treatments used exhibited a degree of control of powdery mildew. Similar studies are planned to further evaluate the spraying of small grain with fungicidal sprays.

Table 1. The effect of various fungicidal sprays on disease control and yield of wheat variety Blueboy. Agronomy Research Farm, Poplar Hill, Quantico, Maryland. 1974

Treatment[1/]	Rate (Dosage/Acre)	Yield[2/] (Bu/A)	Percent Yield Increase
Milstem-Col YF 6348[3/]	12 fl oz	30.7	6.6
Milstem-Col YF 6348	8 fl oz	29.3	1.7
Milstem-Col YF 6348	2 fl oz	31.9	10.8
Benlate[4/]	1/2 lb	32.4	12.5
Milstem-Col YF 6348 + Manzate 200	12 fl oz + 2 lb	31.5	9.4
Milstem-Col YF 6348 + Manzate 200	8 fl oz + 2 lb	31.9	10.8
Milstem-Col YF 6348 + Manzate 200	2 fl oz + 2 lb	30.0	4.2
Benlate + Manzate 200	1/2 lb + 2 lb	31.2	8.3
Milstem-Col YF 6348 + Manzate 200 (2 appl)	8 fl oz + 2 lb	34.6	20.1
Benlate + Manzate 200 (2 appl)	1/2 lb + 2 lb	33.9	17.7
Manzate 200 (2 appl)	2 lb	30.7	6.6
Control (Unsprayed)	----	28.8	----

1/ Fungicidal sprays applied on April 8 @ 22.5 gal/A. Second application made on April 23.
2/ Mean yield of four replicated plots (12' x 20') harvested on July 4.
3/ Cirrasol (spreader-sticker) at 3 fl oz/A used in all sprays with Milstem-Col YF 6348.
4/ Triton B1956 (spreader-sticker) at 3 fl oz/A used in all sprays with Benlate and Manzate 200.

Table 2. Control of powdery mildew of Blueboy wheat with fungicidal sprays. Agronomy Research Farm, Poplar Hill, Quantico, Maryland. 1974

Treatment[1/]	Rate (Dosage/Acre)	Percent[4/] Infection (5/10)
Milstem-Col YF 6348[2/]	12 fl oz	2.6
Milstem-Col YF 6348	8 fl oz	2.5
Milstem-Col YF 6348	2 fl oz	3.5
Benlate[3/]	1/2 lb	4.4
Milstem-Col YF 6348 + Manzate 200 (2 appl)	8 fl oz + 2 lb	1.6
Benlate + Manzate 200 (2 appl)	1/2 lb + 2 lb	2.2
Control (Unsprayed)	----	8.4

1/ Fungicidal sprays applied on April 8 @ 22.5 gal/A. Second application made on April 23

2/ Cirrasol (spreader-sticker) at 3 fl oz/A used in all sprays with Milstem-Col YF 6348.

3/ Triton B1956 (spreader-sticker) at 3 fl oz/A used in all sprays with Benlate and Manzate 200.

4/ Percent infection based on infection present on 20 leaves selected at random from each of 4 replicates.

Residual Effect of Thirteen Cropping Systems on Corn Yield and Soil Aggregation

E. Strickling
Department of Agronomy

Purpose and Objectives

To determine the residual effect of thirteen cropping systems with two levels of nitrogen (100 N and 200 N) on corn yields and on soil aggregation.

Procedure

A cropping system experiment including 13 cropping systems, was established in 1952 on Beltsville silt loam. The cropping systems established ranged in intensity of cultivation from continuous bare fallow that was plowed and disced each year to continuous grass that was not tilled after establishment. Fertilization was uniform on all plots at the rate of 100 lbs of N and 1000 lbs of 0-12-12 per A per year. In 1959 the plots were split and 70 lbs of additional nitrogen was applied to half of each plot. Date of plowing was moved ahead approximately one month at this time because it was assumed that the late April plowing was reducing the corn yields of plots in grass or hay the previous year. From 1959 to the termination of the experiment in 1972 there were differences in corn yield associated with cropping systems in spite of the heavy nitrogen fertilization. In 1973 and 1974 all plots were planted to corn in an effort to evaluate the residual effects of cropping systems. The nitrogen split was increased from 70 lbs/A of additional N to 100 lbs/A. Data for 1973 and 1974 are presented in Table 1.

Results

Due to the requirement that all crops of each rotation must appear every year in each replication of a statistically sound cropping sequence experiment, the placing of all plots in corn following a cropping sequence experiment allowed an excellent comparison between first year corn and second year corn on plots in the same rotations in 1973. For instance, in the corn, wheat, hay rotation there was a plot of each crop in each replication in 1972. When corn was planted in all plots in 1973, corn followed corn in the first plot and corn followed hay in the third plot. By comparing the yields from these two "treatments" in each replication it was possible to obtain a rather unique comparison between first year corn (110.4 bu/A) and second year corn (85.5 bu/A) in the same rotation. This comparison could be made in seven different cropping systems and the averages for the seven cropping systems are presented at the bottom of Table 1. First year corn yields averaged 105.3 bu/A as compared to 84.8 bu/A for second year corn. Soil aggregate stability and organic matter content were directly correlated with the corn yields. The low corn yields of plots previously in continuous bare fallow (26.9 bu/A), continuous corn (50.1 bu/A) and continuous soybeans (66.0 bu/A) are especially noteworthy when compared with yields following continuous orchardgrass (127.1 bu/A) and continuous bluegrass (124.6 bu/A).

The continuous wheat in this experiment was seeded each fall without plowing. Average wheat yield over the twenty years of this experiment for continuous wheat (31 bu/A) was somewhat lower than the average wheat yield for all cropping systems containing wheat (35 bu/A), but organic matter and aggregation were high at the end of the experiment which was reflected in the corn yields in 1973 and 1974 (134.7 and 142.3 bu/A, respectively).

The lack of a response of corn in all cropping systems to extra nitrogen is typical of previous data from this experiment. It was not possible to eliminate yield differences associated with cropping sequences by increasing the nitrogen applied.

The 1974 data continued to reflect the residual soil differences due to 20 years of different cropping systems. The 1974 data allowed a unique comparison of second year corn (124.8 bu/A) and third year corn (112.6 bu/A) indicating that the third year of corn had a depressing effect on yield but the percentage of difference between second and third year was not as great as it was between first and second year corn in 1973. Plots previously in bare fallow yielded relatively better (68 bu/A) in 1974 indicating some beneficial effect from the corn grown on these plots in 1973.

Summary

Corn yields were closely correlated with soil aggregation and soil aggregation was best on plots that previously had been in cropping systems that included alfalfa or pasture crops. Aggregation was also high in the plots previously in continuous wheat plots which had grown wheat twenty years without plowing.

Second year corn yields were only 80.5% of the first year corn yields and third year corn was 90.8% of the second year corn yield.

Table 1. Corn yields and soil aggregate stability in 1973 and 1974 and soil organic matter content in 1973 of plots on Beltsville silt loam soil that had been in thirteen different cropping systems from 1952 to 1973 and in corn in 1973 and 1974.

Cropping System* and Previous Crops **	Corn Yields						Soil Aggregation		Soil Organic Matter
	100 N		200 N		Ave.				
	73	74	73	74	73	74	6/8/73	6/18/74	6/8/73
	bu/A	bu/A	bu/A	bu/A	bu/A	bu/A	%	%	%
Cont. Bare Fal.,C	32.1	....	21.7	....	26.9	....	6.0	....	.85
Cont. Bare Fal.,C,C	....	80.6	....	55.8	....	68.2	....	7.7	....
Cont. Corn, C	50.8	....	49.4	....	50.1	....	11.9	....	1.66
Cont. Corn, C,C	....	86.8	....	95.9	.....	91.4	....	10.9	....
Cont. Soybeans, C	65.9	....	66.0	....	66.0	....	8.7	....	1.39
Cont. Soybeans, C,C	....	109.3	....	129.8	....	119.6	....	8.9	....
Cont. Blgr., C	135.3	....	113.8	....	124.6	....	45.7	....	2.24
Cont. Blgr., C,C	....	136.8	....	128.4	....	132.6	....	28.5	....
Cont. Orchgr., C	131.1	....	123.1	....	127.1	....	43.0	....	2.26
Cont. Orchgr., C,C	....	142.7	....	131.8	....	137.3	....	26.9	....
Cont. Wheat, C	144.5	....	125.0	....	134.7	....	41.9	....	2.15
Cont. Wheat, C,C	....	148.0	....	136.6	....	142.3	....	23.3	....
C°,W,C	90.4	....	84.4	....	87.4	....	34.3	....	1.75
C°,W,C,C	94.0	119.7	72.1	102.3	83.1	111.0	21.5	20.0	1.75
C°,W,C,C,C	....	111.4	....	108.6	....	110.0	....	16.0	....
C,W,C	93.9	....	98.9	....	96.4	....	28.2	....	1.75
C,W,C,C	73.2	115.7	58.5	112.6	65.9	114.1	18.4	14.1	1.75
C,W,C,C,C	....	109.2	....	90.3	....	99.8	....	15.4	....

Cropping System* and Previous Crops**	Corn Yields						Soil Aggregation		Soil Organic Matter
	100 N		200 N		Ave.				
	73	74	73	74	73	74	6/8/73	6/18/74	6/8/73
	bu/A	bu/A	bu/A	bu/A	bu/A	bu/A	%	%	%
SwC,W,C	100.1	....	99.4	....	99.7	....	26.8	....	1.78
SwC,W,SwC,C	78.9	120.2	57.3	124.9	68.1	122.6	31.3	17.3	1.65
SwC,W,SwC,C,C	....	108.7	....	109.6	....	109.1	....	12.2	....
C,S,W,C	96.2	....	112.4	....	104.3	....	25.0	....	1.81
C,S,W,C,C	88.9	116.6	85.8	122.3	87.4	119.4	14.7	18.5	1.84
C,S,W,C,C,C	....	113.2	....	116.0	....	114.6	....	14.6	....
C,W,H,C	110.6	....	110.3	....	110.4	....	30.2	....	1.94
C,W,H,C,C	80.9	138.9	96.0	120.7	85.5	129.8	17.3	20.2	1.82
C,W,H,C,C,C	....	105.1	....	114.1	....	109.6	....	12.1	....
C,W,H,H,C	95.9	....	106.5	....	101.2	....	24.9	....	2.07
C,W,H,H,C,C	91.4	119.5	113.6	137.3	102.5	128.4	21.0	17.3	1.92
C,W,H,H,C,C,C	....	121.3	....	133.9	....	127.6	....	15.8	....
C,W,P,P,P,C	152.3	....	123.2	....	137.7	....	40.6	....	2.19
C,W,P,P,P,C,C	103.0	145.1	93.0	140.2	98.0	142.6	23.7	22.5	1.94
C,W,P,P,P,C,C,C	....	123.0	....	111.7	....	117.4	....	15.8	....
Ave. 1st yr. corn	105.6	....	105.0	....	105.3	....	30.0	....	1.90
Ave. 2nd yr. corn	87.2	125.1	82.3	122.9	84.8	124.0	21.1	18.6	1.81
Ave. 3rd yr. corn	....	113.1	....	112.0	....	112.6	....	14.6	....

* = cropping systems followed for 20 years previous to C are underlined.
C°= corn with stalks left on; SwC = sweet corn; W = wheat; Fal. = fallow; Blgr. = bluegrass; Orchgr. = orchardgrass; H = alfalfa hay; P = orchardgrass and ladino clover; S = soybeans.
** There is only one group of plots in each continuous cropping system and two groups under each rotation. The cropping system followed by one year of C in 1973 became the same cropping system followed by 2 years of C in 1974. Likewise, cropping system C,C in 1973 became cropping system C,C,C in 1974.

Effect of NaCl on Soil Microbiological Properties

R. W. McCormick and D. C. Wolf
Department of Agronomy

Purpose and Objectives

The cooling towers scheduled to begin operation in spring 1973 at the Chalk Point power plant will be using brackish water. As a result of the salts present in the water used by the cooling tower, it is possible that significant levels of salt will be dispersed in the atmosphere and deposited on the surrounding soil. These experiments were designed to study the effect of NaCl on microbial respiration, nitrification rate, and the population of fungi and bacteria in the soil.

Procedures

To determine the effect of NaCl on microbial respiration, a Sassafras sandy loam was selected for the study and amended with 0.5% ground alfalfa meal. The NaCl was added to 200g soil samples at rates of 0, 2500, 5000, and 50,000 ppm by dissolving the required NaCl in the water added to bring the soil to 60% of the water holding capacity. All treatments were replicated three times and a blank included.

Respiration rate was determined by monitoring the CO_2 evolved from the soil system. Water saturated CO_2 free air was continually passed over the soil then through a KOH solution to trap the evolved CO_2. Samples were collected over a 14 week period and titrated to determine the amount of CO_2 evolved.

The nitrification rate was determined by measuring the NH_4-N and NO_3-N in the soil after the incubation by the Kjeldahl procedure.

To assess the effect of NaCl on microbial numbers, soils from soybean salt spray plots at the Tobacco Research Farm were utilized. These soils had received 0, 1.8, 3.6, 7.3, and 14.6 kg ha^{-1} of NaCl in solution as a spray mist on a weekly basis for eight weeks. Soil samples from the 0-15 cm depth were taken at the second and eighth week of spraying and four weeks after spraying was discontinued. Samples were plated on glucose-peptone agar for determining the bacterial population and on Martin's medium for determining the fungal population. Each treatment was replicated four times.

Results

The effect of NaCl on microbial respiration is given in Table 1. Microbial respiration was reduced 22% by 2,500 ppm NaCl, 25% at 5,000 ppm NaCl and 73% of the 50,000 ppm NaCl rate. Decreased respiration due to the presence of salts can be attributed to the high osmotic potential, a toxic quantity of salt, or inhibition of nutrient uptake.

After 14 weeks of incubation, NaCl levels of 5,000 and 50,000 ppm sharply reduced NO_3-N while increasing NH_4-N in the soil (Table 2). The results indicate that high NaCl levels in soil inhibit the nitrification process.

Field studies to determine the effect of NaCl on microbial numbers showed that there was no significant differences between either bacterial or fungal numbers and salt treatments at any of the sampling times or salt rates. This may be partly due to the presence of the soybean plant removing the NaCl from the soil, the roots providing an environment whereby the microbial population would not be adversly affected by low levels of NaCl, or the NaCl was moving through the soil at such a rate that inhibitive quantities did not accumulate.

Summary

It was concluded that NaCl levels of 2,500 ppm and higher in the soil sharply inhibited microbial respiration while levels of 5,000 ppm or higher inhibited nitrification. Low levels of salt applied to field soils over a two month period had no apparent effect on soil microbial numbers.

Acknowledgement

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Table 1. Rate of CO_2 evolution from a Sassafras sandy loam amended with 0.5% ground alfalfa meal and four NaCl levels.

Time (weeks)	ppm NaCl Added			
	0	2,500	5,000	50,000
	mg C as CO_2			
1	197.5±1.3[1/]	172.6±4.6	163.8±3.8	18.0±2.1
5	313.5±0.8	254.2±6.0	238.5±4.1	60.4±8.4
10	375.1±0.8	295.5±4.8	284.5±3.4	92.5±9.6
14	388.9±2.0	304.3±4.6	292.8±3.3	104.5±10.4
% reduction in CO_2 evolution		22%	25%	73%

[1/] All values are means followed by ± one standard deviation.

Table 2. The effect of NaCl on the NH_4-N and NO_3-N levels in a Sassafras sandy loam amended with 0.5% ground alfalfa meal and incubated at 60% water holding capacity for 14 weeks.

NaCl Added (ppm)	NH_4-N	NO_3-N
	ppm	
0	8.1±2.1[1/]	101.1±14.8
2,500	8.3±1.6	98.8±47.8
5,000	35.9±4.6	37.0±2.1
50,000	22.5±2.5	7.7±0.7

[1/] All values are means followed by ± one standard deviation.

Nitrogen Relationships in Sewage Sludge-Amended Soils

G. C. Stanton and D. C. Wolf
Department of Agronomy

Purpose and Objectives

Current wastewater treatment facilities remove 20,000 tons of sludge per day in the United States. The immediate concern is disposal of a biologically active material in a manner that does not harm the ecosystem in which it is deposited. It is necessary to understand the fate of the sludge nitrogen in soils if land application of sludge is to be practiced.

The objective of this study was to investigate the disposition of NH_4-N, NO_3-N, and organic-N in sludge-soil systems. The effect of loading rate and time on two soil types was evaluated.

Procedures

A Chester silt loam (pH 6.2) and a Chillum silt loam (pH 4.4) were air-dried and sieved before amendment with activated sludge (80% moisture). Sludge was added at rates of 0, 21, and 85 dry tons/acre and thoroughly mixed with the 100g soil samples. Sufficient distilled water was added to bring the samples to 60% water holding capacity and the flasks were incubated at room temperature. Analyses were performed after 0, 30, and 180 days.

Organic-N, NH_4-N, and NO_3-N were analyzed by Kjeldahl distillation procedures. Measurement of pH was made on soil sample-distilled water mixtures (1:1 by weight).

Results

The NO_3-N, NH_4-N, organic-N and total N values are presented in Table 1. The data show an accumulation of NH_4-N in the Chillum silt loam. The NH_4-N level was highest after six months in the 85 dry tons/acre sludge-

amended Chillum soil. There was minimal NO_3-N production in this soil. The Chester silt loam showed a build-up of NO_3-N and a decrease in NH_4-N. Organic-N and total-N levels remained steady for both soil types at a given sludge rate. The pH values are given in Table 2. The addition of sludge affected an increase in pH of all samples at 0 time. The Chester soil showed a decrease in pH with time at all loading rates. The 0 and 21 dry tons/acre sludge-amended Chillum soil exhibited a slight increase in pH for the 180 day period. The 85 dry tons/acre sludge treated Chillum soil showed a decrease in pH after 6 months.

Summary

The data show an inhibitory effect on nitrification in the acidic Chillum silt loam. The near-neutral Chester silt loam provided a more suitable environment for NO_3-N production. The sludge-amended Chester soil exhibited a greater decrease in pH than the Chillum silt loam.

Table 1. The NO_3-N, NH_4-N, organic-N and total-N values from in vitro soil-sludge systems incubated at 60% water holding capacity.

Treatment	Time period (days)	NO_3-N[1/]	NH_4-N	Organic-N	Total-N
		ppm			
Chester 0 dry T/A	0	2	12	1300	1310
	30	51	1	1400	1450
	180	128	7	1200	1340
Chillum 0 dry T/A	0	6	3	840	849
	30	0	28	760	788
	180	17	50	670	737
Chester 21 dry T/A	0	4	65	1930	2000
	30	170	3	2110	2280
	180	241	1	1940	2180
Chillum 21 dry T/A	0	4	46	1540	1590
	30	1	200	1560	1760
	180	37	310	1530	1880
Chester 85 dry T/A	0	6	150	3800	3960
	30	120	22	3790	3930
	180	260	2	3430	3690
Chillum 85 dry T/A	0	8	160	3140	3310
	30	0	700	2560	3260
	180	34	630	2870	3500

[1/] All N values are a mean of two replicates and reported on a dry weight basis.

Table 2. The pH values obtained from *in vitro* soil-sludge systems incubated at 60% water holding capacity.

Treatment	pH		
	0 days	30 days	180 days
Chester 0 dry T/A	6.2	5.5	5.2
Chillum 0 dry T/A	4.4	4.4	4.5
Chester 21 dry T/A	6.2	5.3	4.8
Chillum 21 dry T/A	4.8	4.9	5.2
Chester 85 dry T/A	6.3	6.2	5.6
Chillum 85 dry T/A	5.6	5.6	4.9